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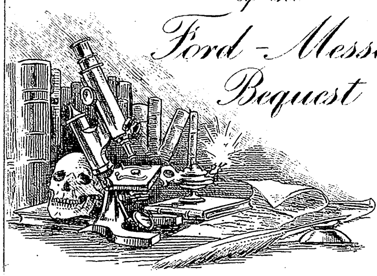
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VOLUME XL.

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JOURNAL OF THE SOCIETY OF ARTS.

No. 2035.] *FRIDAY, NOVEMBER* 20, 1891. [*Vol. XL.*

ONE-HUNDRED-AND-THIRTY-EIGHTH SESSION, 1891-92.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Thirty-eighth Session of the Society was held on Wednesday, the 18th November, when the Opening Address was delivered by the Attorney-General, M.P., Chairman of the Council. The following arrangements have been made for the four meetings before Christmas:—

November 18.—The Attorney-General, M.P., Chairman of the Council, Opening Address.

,, 25.—Prof. Silvanus P. Thompson, F.R.S., "Measurement of Lenses." Prof. Carey Foster, F.R.S., will preside.

December 2.—G. H. Robertson, F.C.S., "Secondary Batteries." W. H. Preece, F.R.S., will preside.

,, 9.—James Dredge, "The World's Fair at Chicago, 1893." The Attorney-General, M.P., will preside.

,, 16.—Prof. Vivian B. Lewes, "Spontaneous Ignition of Coal, and its Prevention."

For meetings after Christmas:—

E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships."
T. PRIDGIN TEALE, "Dust, and How to Shut it Out."
GENERAL PITT RIVERS, "Typological Museums."
T. ANDERSON, "Iceland."
I. W. TONKS, "Artistic Treatment of Jewellery and Personal Ornament."
SIR WILLIAM WEDDERBURN, Bart., "Agricultural Banks for India."
F. W. EDRIDGE-GREEN, M.D., "The Scientific Value of Lovibond's Tintometer."
DR. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."
LORD LAMINGTON, "Travels in Indo-China."
WILLIAM MORRIS, M.A., "The Woodcuts of Gothic Books."
J. W. WILLIS BUND, "The Fisheries Department, its Position and Prospects."
CAXTAIN V. LOVETT CAMERON, R.N., "The Congo State."

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Afternoons, at Half past Four o'clock:—

January 19, February 16, March 15, April 5, 26, May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 26, February 23, March 8, 29, April 12, May 17.

CANTOR LECTURES.

These lectures will be delivered on the following Monday Evenings, at Eight o'clock:—

A. P. LAURIE, M.A., "The Pigments and Vehicles of the Old Masters." Three Lectures.

LECTURE I.—NOVEMBER 30.—A brief account of fresco painting as described by Cennino Cennini, and of the preparation of panels, gesso work and gilding in the 15th century. Also a description of the preparation of gilt Spanish leather.

LECTURE II.—DECEMBER 7.—The pigments used in the 15th century, and their preparation and properties, with some account of the methods of painting.

LECTURE III.—DECEMBER 14.—The mediums used by the Old Masters, in tempera and oil painting. The preparation of the oils and varnishes, and the properties of the same.

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

January 25, February 1, 8, 15.

PROF. WILLIAM ROBINSON, M.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.

March 28, April 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.

May, 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, on "The Three States of Matter," will be delivered by Professor J. M. THOMSON, F.C.S., on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

CHICAGO EXHIBITION, 1893.

The Council of the Society has been appointed a Royal Commission for the Chicago Exhibition, 1893. All applications for space in the British Section, and all inquiries for information about the Exhibition, should be addressed to the Secretary of the Royal Commission, Society of Arts, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Roya Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, of Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886 for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

Juvenile Lectures.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

Admission to Meetings.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

Journal of the Society of Arts.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

Examinations.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

Conversazioni are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni.*

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1891-92. It is issued subject to any necessary alterations:—

NOVEMBER, 1891.

1	**S**	
2	M	
3	Tu	
4	W	
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	
18	W	Ordinary Meeting (Opening Meeting of the Session)
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture I. 1

DECEMBER, 1891.

1	Tu	
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	**S**	
7	M	Cantor Lecture I. 2
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture I. 3
15	Tu	
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	
24	Th	
25	F	Christmas Day
26	S	*Bank Holiday*
27	**S**	
28	M	
29	Tu	
30	W	
31	Th	

JANUARY, 1892.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	Juvenile Lecture 1
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	Juvenile Lecture 2
14	Th	
15	F	
16	S	
17	**S**	
18	M	
19	Tu	For. & Col. Section
20	W	Ordinary Meeting
21	Th	Indian Section
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture II. 1
26	Tu	Applied Art Section
27	W	Ordinary Meeting
28	Th	
29	F	
30	S	
31	**S**	

FEBRUARY, 1892.

1	M	Cantor Lecture II. 2
2	Tu	
3	W	Ordinary Meeting
4	Th	
5	F	Howard Lecture 1
6	S	
7	**S**	
8	M	Cantor Lecture II. 3
9	Tu	
10	W	Ordinary Meeting
11	Th	Indian Section
12	F	Howard Lecture 2
13	S	
14	**S**	
15	M	Cantor Lecture II. 4
16	Tu	For. & Col. Section
17	W	Ordinary Meeting
18	Th	
19	F	Howard Lecture 3
20	S	
21	**S**	
22	M	
23	Tu	Applied Art Section
24	W	Ordinary Meeting
25	Th	
26	F	Howard Lecture 4
27	S	
28	**S**	
29	M	Cantor Lecture III. 1

MARCH, 1892.

1	Tu	
2	W	Ordinary Meeting
3	Th	Indian Section
4	F	Howard Lecture 5
5	S	
6	**S**	
7	M	Cantor Lecture III. 2
8	Tu	Applied Art Section
9	W	Ordinary Meeting
10	Th	
11	F	Howard Lecture 6
12	S	
13	**S**	
14	M	Cantor Lecture III. 3
15	Tu	For. & Col. Section
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture III. 4
22	Tu	
23	W	Ordinary Meeting
24	Th	Indian Section
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture IV. 1
29	Tu	Applied Art Section
30	W	Ordinary Meeting
31	Th	

APRIL, 1892.

1	F	
2	S	
3	**S**	
4	M	Cantor Lecture IV. 2
5	Tu	For. & Col. Section
6	W	Ordinary Meeting
7	Th	
8	F	
9	S	
10	**S**	
11	M	Cantor Lecture IV. 3
12	Tu	Applied Art Section
13	W	Ordinary Meeting
14	Th	
15	F	Good Friday
16	S	
17	**S**	Easter Sunday
18	M	*Bank Holiday*
19	Tu	
20	W	
21	Th	
22	F	
23	S	
24	**S**	
25	M	
26	Tu	For. & Col. Section
27	W	Ordinary Meeting
28	Th	Indian Section
29	F	
30	S	

MAY, 1892.

1	**S**	
2	M	Cantor Lecture V. 1
3	Tu	
4	W	Ordinary Meeting
5	Th	
6	F	
7	S	
8	**S**	
9	M	Cantor Lecture V. 2
10	Tu	
11	W	Ordinary Meeting
12	Th	
13	F	
14	S	
15	**S**	
16	M	Cantor Lecture V. 3
17	Tu	Applied Art Section
18	W	Ordinary Meeting
19	Th	Indian Section
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture V. 4
24	Tu	For. & Col. Section
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	
31	Tu	

JUNE, 1892.

1	W	
2	Th	
3	F	
4	S	
5	**S**	Whit Sunday
6	M	*Bank Holiday*
7	Tu	
8	W	
9	Th	
10	F	
11	S	
12	**S**	
13	M	
14	Tu	
15	W	
16	Th	
17	F	
18	S	
19	**S**	
20	M	
21	Tu	
22	W	Conversazione
23	Th	
24	F	
25	S	
26	**S**	
27	M	
28	Tu	
29	W	Annual General Meeting
30	Th	

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, Howard Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian and the Foreign and Colonial Sections will commence at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Wednesday, November 19. Present: The Attorney-General, M.P., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.; Sir Frederick Bramwell, Bart., D.C.L., F.R.S.; Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Michael Carteighe; B. Francis Cobb; Sir Philip Cunliffe-Owen, K.C.B, K.C.M.G., C.I.E.; Prof. James Dewar, M.A., F.R.S.; Major-General J. F. D. Donnelly, C.B.; James Dredge; Francis Elgar, LL.D.; Thomas Hawksley, F.R.S.; A. B. W. Kennedy, F.R.S.; C. M. Kennedy, C.B.; John Biddulph Martin; J. Fletcher Moulton, Q.C., F.R.S.; General the Rt. Hon. Sir Henry F. Ponsonby, G.C.B.; Wyndham S. Portal; W. H. Preece, F.R.S.; Prof. W. C. Roberts-Austen, C.B., F.R.S.; Sir Saul Samuel, K.C.M.G., C.B.; with Sir Henry Trueman Wood, Secretary.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

The Royal Commission are now prepared to receive applications from manufacturers and others desirous of taking part in the Exhibition.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

A prospectus giving particulars of charges for space and further information can be obtained at the Society's offices.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 18, 1891; the Attorney-General, M.P., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, Prof. Henry, 60, Queen Victoria-street, E.C.
Allen, James Mason, 11, Gray's-inn-square, W.C.
Allport, William, 36, Southampton-st., Strand, W.C.
Angelo, Elliott, Oriental Club, Hanover-square, W.
Askwith, George Ranken, 119, St. George's-square, S.W.
Barnwell, Richard, Fairfield-works, Govan, near Glasgow.
Basing, Lord, Hoddington-house, Winchfield, Hants.
Beck, William, jun., 3, Glebe-place, Stoke Newington, N.
Bingley, F. S. Norman, M.A., Inner Temple, E.C., and Conservative Club, S.W.
Bisset, James, Corsee-house, Banchory, N.B.
Brevetor, Ernest Frederick, Laburnums, Grove-lane, Stamford-hill, N.
Brown, Frederick Gordon, 17, Finsbury-circus, E.C.
Bury, Henry, M.A., 5, Palace Court-mansions, Bayswater, W.
Cane, Arthur, Spring-vale, Bush-hill-park, Enfield.
Cawston, George, Ascot Wood-house, Ascot
Chandler, Frederick L., Lloyd's, Royal Exchange, E.C.
Cheetham, Howard, Carlton-chambers, 18, St. Ann's-street, Manchester.
Child, Gilbert William, M.A., J.P., Cowley-house, Oxford.
Cleeves, Frederick, East-hill, Rotherham, Yorks.
Copland, William Wallace, The Waterworks, Sheerness.
Corthell, E. L., 205, La Salle-street, Chicago, Illinois, U.S.A.
Cruwys, Robert, 465, Brixton-road, S.W.
Cutler, Thomas William, 5, Queen-square, W.C.
Danson, John Towne, Grasmere, Westmoreland.
Dent, Rev. Charles, 76, Westbourne-terrace, W.
Donald, James, 92, Anerley-park, S.E.
Elwes, Henry John, Preston-house, Cirencester.
Finnemore, Robert Isaac, J.P., Durban, Natal, South Africa.
Fox, Charles, Roslin, Rectory-road, Beckenham, Kent.
Franklin, Henry Abraham, 14, St. Quintin-avenue, North Kensington, W.
Frost, Robert, B.Sc., 8, King's Bench-walk, E.C., and 42, Duke-street, St. James's, S.W.
Gouraud, Col., Little Menlo, Beulah-hill, S.E.
Graves, Walter, Winchester-house, Old Broad-street, E.C.
Greaves, Joseph Edward Elsworth, Engineering School and School of Science and Art, Rochdale, Lancashire.
Grice, Tom Edmund, Belle-vue, Tonbridge, Kent.
Gripper, George, J.P., Tottenham, Middlesex.
Harris, Walter H., 12, Kensington-gore, S.W.
Hay, John, 11, St. Mary-axe, E.C.
Hill, Frederick Barker, 30, Glengall-road, Peckham, S.W.
Hoblyn, Richard Armstrong, 79, Priory-road, West Hampstead, N.W.
Hogg, Quintin, 5, Cavendish-square, W.
Holt, G. Crompton, Albion-house, Congleton, Cheshire.
Hunter, William, Cathay-house, Eltham, Kent.
Husband, John, Moreton-lodge, Mount Pleasant-lane, Upper Clapton, N.E.
Hutt, Alfred Granger, 8, Oxford-road, Kilburn, N.W.

I'Anson, E. Blakeway, M.A., 7A, Laurence Pountney-hill, E.C.
Irvine, Hugh Alexander, Moray-place, Edinburgh.
James, Alfred, 157, West George-street, Glasgow.
Jones, J. Mortimer, 153, Highbury New-park, N.
Jones, W. Campbell, 32, Bedford-row, W.C.
Kenward, James, 280, Hagley-road, Birmingham.
L'Aker, Major John, Ascot-house, Boscombe, Bournemouth, Hants.
Lamington, Lord, 26, Wilton-crescent, S.W.
Lee, John T., 26, Great James-street, Bedford-row, W.C.
Leeson, Rev. Wilfrid Nevill, B.D., 84, Lancaster-gate, W., and New University Club, S.W.
Low, Alexander G., 38, Pembridge-villas, Bayswater, W.
McCormick, Rev. W. T., St. Matthew's-vicarage, Brighton.
McCormick, Robert, 72, Victoria-street, S.W.
Macnab, Henry Black, 1, Queen Victoria-street, E.C.
Martin, William, Lambeth Infirmary, Brook-street, S.E.
Meade, General Sir Richard John, K.C.S.I., 65, Queen's-gate, S.W.
Mewburn, George Francis, 10, Elm-park-gardens, S.W.
Miles, Colonel Samuel Barrett, The Residency, Oodeypore, Rajputana.
Millson, Alvan, Elmsleigh-house, Paignton, South Devon.
Moore, Alfred, 144, Mile-end-road, E., and Whips Cross, Walthamstow, Essex.
Moore, Commander William Osborne, R.N., 8, Western-parade, Southsea, Hants.
Muir, Thomas, 24, York-terrace, Regent's-park, N.W.
Norris, Walter Henry, Hertford.
Oliverson, Thomas, 2, Hyde-park-gate, South Kensington, S.W.
Phillipps, Richard, 78, Onslow-gardens, S.W.
Phillips, Rev. T. Lloyd, M.A., The Abbey, Beckenham, Kent.
Pilbrow, James, Belpi, Worthing, Sussex.
Piper, Charles Welborne, The Craig, Leyland-road, Lee, S.E.
Rawlinson, Alfred John, Newton-le-Willows, Lancashire.
Reade, Captain Charles Edward, R.N., Rodley-house, Willoughby-road, Hampstead, N.W.
Richardson, Edmund William, 50, Finsbury-square, E.C., and Friern Barnet, Middlesex.
Richmond, William Blake, M.A., A.R.A., Beavor-lodge, Hammersmith, W.
Rickett, William Richard, Sunnyfield, West-heath, Hampstead, N.W.
Riley, William Edward, H.M. Dockyard, Devonport.
Robinson, Prof. William, M.E., University-college, Nottingham.
Ryan, W. P., Ingram-court, Fenchurch-street, E.C., and Warrington-house, Richmond, Surrey.
Sadler, Colonel James Hayes, H.B.M. Consulate, Chicago, U.S.A.
Sandbach, Henry, 129, Mount-street, W.
Sanders, Henry C., Victoria Works, Victoria-gardens, Notting-hill-gate, W., and Elm-lodge, Southall, Middlesex.
Sawyer, Claude Gustav, Junior Constitutional Club, Regent-street, S.W.
Scott, Rev. Robert Selkirk, M.A., D.D., 16, Victoria-crescent, Dowanhill, Glasgow.
Scrutton, Alexander James, 75, Old Broad-street, E.C.
Sedgwick, Frederick Joseph, 72, St. Paul's-road, Burdett-road, E.
Seidler, Charles, 46, Eyot-gardens, Hammersmith, W.
Seton-Karr, Heywood Walter, Atherton-grange, Wimbledon, Surrey.
Smiles, Henry, Tregenna, Parkstone, Dorset.
Spielmann, Marion H., 16, Porchester-terrace, Kensington-gardens, W.
Stephens, Alfred, 3, St. Leonard's-terrace, Chelsea, S.W.
Stephens, Thomas Walls, Downe-house, Richmond, Surrey.
Stone, Edward, 5, Finsbury-circus, E.C.
Thomas, John Blount, J.P., 179, High-street, Southampton.
Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch-end, N.
Verden, Henry, Cowley, Middlesex, and 14, Great Winchester-street, E.C.
Walker, William, Longfield-house, Trowbridge.
Walls, Edward John, 44, High-street, Eccleston-square, S.W.
Warner, William Harding, The Birches, Malvern-link, Worcestershire.
Williams, Henry, Norton-house, 79, Down's-park-road, Clapton, N.E.
Williams, Henry W., Park-house, Brentford, Middlesex.
Williams, Lieut.-Col. Robert, J.P., Bridehead, Dorchester.
Wimshurst, Henry William, 16, Thicket-road, Anerley, S.E.
Worland, Alderman Henry, 55, Barking-road, Canning-town, E.
Young, Prof. Sidney, 13, Aberdeen-terrace, White Ladies'-road, Bristol.

The CHAIRMAN delivered the following

ADDRESS.

In addressing the members of the Society of Arts a second time as Chairman of the Council, I rejoice to be able to congratulate the Society on a most successful session. The session of 1890-91 produced, as in my address of last year I expressed the hope that it would, papers well worthy of the Society and of the attention of

the members, thus maintaining the continuity of record to be found in the Transactions of the Society in relation to many important discoveries and inventions.

Before, however, referring to any of these subjects, I must refer to the losses by death sustained by the Society. I am thankful to say that these are comparatively few in number; they include the names of the Archbishop of York, Lord Granville, Sir John Hawkshaw, Mr. Loftus Perkins, Leonard C. Wyon, Mr. Willoughby Smith, Mr. William Hallowes, James Shirley Hibberd, and Mr. William A. Barrett. With regard to some of these it is fitting that I should add a few words in addition to the passing enumeration of their names. The pressing avocations of Dr. Thompson, the Archbishop of York, had prevented him during the latter years of his life from taking part in the progress of the Society, but I am glad to record, as an example to others, that he was the first examiner in logic and mental science appointed by the Council in the year 1860, and held that appointment until his translation to York.

Lord Granville was one of the oldest members of the Society, and was for many years closely connected with its work. He was elected a member in 1848, and was a Vice-President from 1849 to 1872; he again served on the Council from 1876 to 1880, and from 1882 to 1885. He on several occasions presided at the evening meetings of the Society, and took the chair at the centenary dinner held at the Crystal Palace in the year 1854. I need not remind members present that he was a Vice-President of the Royal Commission for the Great Exhibition of 1851, and Chairman of the Exhibition of 1862, and as late as the year 1868, when a very important conference was held under the auspices of the Society of Arts on the subject of technical education, Lord Granville showed his active interest in the subject and delivered a most important speech at one of the meetings of the conference.

In Sir John Hawkshaw the country has lost one of its most distinguished civil engineers, and the Society again one of its oldest members. He presided on many occasions, and took an active part in the discussions at the evening meetings.

In reference to the name and work of Loftus Perkins, there are many present in this room who were well acquainted with him and his work, and who still retain a lively recollection of his genial manners, affectionate disposition, and generous character. He was a descendant of Jacob Perkins, an American, who spent a large portion of his life in England, and himself took out no less than nineteen patents at a time when each patent cost £200, and who received a medal from the Society of Arts. His father, Mr. Angier Mark Perkins, also a member of the Society, developed a system of heating by high-pressure water, and invented the fixed and portable baking ovens now so well known throughout the whole length of this country. Mr. Loftus Perkins inherited, in no small degree, the inventive genius of his father and grandfather. He undoubtedly first had the courage to use, as it proved, with perfect safety, steam at a pressure which, but a few years before, would have been regarded as being beyond control, and in any description of the modern development of the steam-engine the work of Mr. Loftus Perkins must receive full notice. Nor were his talents confined to this subject only. The improved ammonia freezing apparatus, fully described in Mr. Graham Harris's course of Cantor lectures on "Heat Engines other than Steam," was perfected by him. He died at the comparatively early age of fifty-seven, his death being to a great extent brought about by the incessant labour entailed upon him in working up his inventions.

Mr. Leonard Wyon had been, from the year 1852, a member of the Society. He was the son of Mr. William Wyon, R.A., the chief engraver to the Mint. For many years he designed and produced all the medals of this Society, and his name, and that of his father, will long be connected with the art of engraving and modelling in metal.

The last of the names which time permits me to notice is that of William Alexander Barrett, who has for the last twelve years acted as the Society's examiner in music. I will not refer to the numerous works of Mr. Barrett, or to his association with many distinguished men in the development of musical education in this country. Those who remember his lectures on old English music, and the charming illustrations by which they were accompanied, will feel, I am sure, that these few words of regret for his loss find a fitting place in the address of the Chairman of the Council of the Society.

I now turn to a point of a pleasurable character, and that is to remind you that the Albert Medal for the year 1891 was presented, by the selection of our President, H.R.H. the Prince of Wales, on the recommendation of

the Council, to Sir Frederick Abel. On the present occasion, and in his presence, I cannot enlarge on the services which gained for Sir Frederick this well earned and honestly merited distinction; but all who have known Sir Frederick's work, and who know the self-denying life that he has passed in connection with his public services, will feel that amongst the many distinguished men whom this Society has been able to honour with the medal—which is regarded by all who receive it as one of the greatest honours that a scientific man can receive—there has been no more worthy recipient of it than Sir Frederick Abel.

It will be in the recollection of those who were good enough to attend, or to read my observations last year, that I at considerable length pointed out how there would be found in the papers from time to time read before the Society of Arts an almost complete history of various inventions, from their earliest conception to their ultimate development. Further consideration and experience has led me to ascertain that I by no means exhausted or did full justice to the work of this Society from that point of view; and were it possible to devote time to the elaboration of that subject, a most interesting and useful paper might be prepared, indicating particular dates at which the various steps of invention, which have been so rapid during the present century, took place. As, however, there are other subjects upon which it is of more importance that I should occupy your attention this evening, I propose to bestow only a very short period of the time allotted to me upon the subject, to which I have already referred. In connection, however, with the work of this Society I shall later on this evening have to present medals to those who have rendered distinguished service to the Society and its members by the merit of the papers which have been read during the last session, and I therefore desire for a few moments to supplement my address of last year by one or two further illustrations founded upon those papers.

There was read in the autumn of 1890 a most valuable paper by Messrs. Green, Cross, and Bevan, on "Photography in Aniline Colours," in respect of which the Society awarded one of their silver medals. It is interesting to note a fact, which escaped my attention last year, that in the year 1839 the silver medal of the Society was presented to Mr. J. T. Cooper for his method of preparing paper for photographic drawings. Closely connected to this is the subject of the paper of Professor J. G. Hummel, on "Fast and Fugitive Dyes." From its foundation, the Society has shown a keen interest in the improved production of dyes. Among the earliest premiums awarded were some in respect of the growth of madder in this country and the discovery of cobalt; and in the first extant volume of Transactions, published in the year 1783, it is announced that English madder, produced largely in consequence of the encouragement and awards offered by the Society of Arts, was found as good, at least, if not better, than any imported. And, again, in the year 1871, a most valuable series of Cantor lectures was delivered by Dr. Crace Calvert on "Dyes and Dye Stuffs other than Aniline."

Dealing with the artistic division of the Society's work, I have to notice two very remarkable papers, the merit of which in my judgment stands very high among the communications made to the Society. I refer to the papers of Mr. A. P. Laurie on the "Durability of Pictures Painted with Oils and Varnishes," and that of Mr. William Simpson on the subject of "Lithography." As early as 1786, a Miss Greenland brought before the Society a communication respecting the desirability of a substituted vehicle for colours in the place of oil. This paper will be found in the 5th vol. of the Transactions of the Society. She received a gold palette for her painting in wax, in accordance with the description as given in the Transactions; and, in 1797 and 1801, Timothy Sheldrake communicated to the Society papers "On the Nature and Preparation of Drying Oils for Painting Pictures;" in respect of which paper the silver palette was twice awarded to him by the Society. It is further interesting to notice that the distinguished artist, Mr. Holman Hunt, who presided on the occasion of the reading of Mr. Laurie's paper, read in the year 1880 a very valuable paper on the "Present System of obtaining Materials in use by Artist Painters," for which the Society's silver medal was awarded to him. I have not by any means exhausted the list in connection with this subject, but I have indicated again the continuity of interest evinced by the Society in this branch of art.

With reference to Mr. William Simpson's paper on "Lithography," in the year 1819 the gold medal of the Society of Arts was presented to Senefelder for his discovery of lithography; and it is recorded that he was so much gratified at the award that one of his lithographic

presses was presented to the Society. Medals were subsequently awarded to Hulmandel and Joseph Netherclift, and in 1847 a collection of specimens illustrative of the progress of lithographic art in England was exhibited in the rooms of the Society. If Mr. William Simpson be right in the argument of his paper, that lithography may be termed a finished chapter of illustrative art, it is not an exaggeration to say that every important step in its progress has been fostered and encouraged by the action of the Society of Arts. I shall have occasion to refer again, later in the evening, to this subject in connection with the pleasing duty which is imposed upon me of presenting the medals, and I pass from it now, commending it again earnestly to those who have the power and inclination to collect for the information of their brother members a record of progress and invention in any particular subject-matter.

I have every reason to hope that the coming sessions of the Society of Arts will be worthy of those that have gone before, and that the papers likely to be communicated and read to the various meetings will be at least of as much public interest, and contain as valuable information, as any preceding series. And I would commend to the members of the Society the extreme importance of attending at the meetings, in order that an effective discussion and criticism may follow the reading of papers in which matters of public interest, or the development of inventions, are discussed.

There is one other branch of the Society's work to which time will only permit me to give very passing notice, and that is the subject of Examinations. I need not remind my hearers that the interest which has been from time to time evinced in these examinations, or of the interest with which they have been supported by the public; but the figures for the last few years are exceedingly encouraging. Since the year 1885, that is to say, in the seven years from 1885 to 1891 inclusive, the number of papers worked in the examinations has doubled, *i.e.*, there were 1,313 in 1885, and 2,667 in 1891. I wish also to call attention to the improved standard of those who competed at these examinations; for, whereas in the year 1890, out of 2,474, 205 first-class certificates—in itself a very high average—were awarded by the examiners, in the year 1891 no less than 295, that is to say, nearly 15 per cent. of those who sent in papers obtained first-class certificates. I am quite certain, from the communications I have from time to time received with reference to these examinations, that they form a most useful part of the work of this Society, and one which strongly merits encouragement.

I now approach a subject of great interest to the Society, and which in one sense forms a novel feature in our proceedings to-day. I have to announce that Her Most Gracious Majesty has been pleased to appoint the President, Vice-Presidents, and Council of the Society of Arts, a Royal Commission for the International Exposition which is to be held at Chicago in the year 1893. I need scarcely say that the Council regard this, and I think the members of the Society will agree, as a very high compliment to the Society and a most gracious tribute to its work; and I shall, before I close my observations, appeal to all present, and to the members of the Society in all parts of the world, to render their assistance to the utmost of their power in justifying the selection so graciously made. It is not, however, unfitting that on such an occasion, and in view of such a fact, I should make a few observations upon the subject of exhibitions of the kind, and should also recall to the members of the Society of Arts the part that the Society has played in previous exhibitions. It is not saying too much to assert that the founders of the Society of Arts, or those who controlled its operations during the earliest periods of its existence, were the inventors of industrial exhibitions. Many suggestions have been made as to the first origin of exhibitions of this class, but I doubt if it is possible to discover their absolute origin. Sir Theodore Martin, in his "Life of the Prince Consort," traces them back to the mediæval fairs, and especially the fairs at Frankfort. The idea is ingenious, but I think it will be found that fairs were general throughout Europe at a much earlier period than the 16th century, and that they had little in common with the class of exhibitions to which I am about to refer. The French have claimed that the idea of industrial exhibitions originated with them, and, undoubtedly, in the year 1798, the then Minister of the Interior conceived and published the idea of annual public exhibitions of the products of French industries, and in September of that year such an exhibition was actually held in Paris. But, according to the report of the Paris Exhibition of 1889, which has recently been published, this had been preceded by an industrial exhibition held at

Prague in the year 1791. The French industrial exhibitions were carried out for some years, and it is certain that their success had some part in suggesting the idea of the great International Exhibition of 1851. But it must be remembered that the French exhibitions were distinctly national, and therein lay the great difference between the Exhibition of 1851 and subsequent exhibitions, and those which had preceded them. Strangely enough, a proposal in the year 1849 that the French Exhibition of that year should be international was rejected, and it affords marked testimony to the foresight of our then President, the late Prince Consort, that in the same year when asked by Mr. Cole as to whether he thought the British Exhibition shonld be national or international, the Prince replied at once "International, certainly." The minute, corrected in his Royal Highness's own handwriting, is in the possession of the Society. But simultaneously with the development of exhibitions in France, the first idea had been taking root and suddenly grew in this country. I believe the first exhibition of pictures was that held in the Louvre in the year 1699. The first exhibition in England was in the rooms of this Society in the year 1761. It was under the management of the Society, and the first of a series held under its direction, out of which series grew the annual exhibition of the Royal Academy. Again the distinction of the initiation of the first exhibition of an industrial character may certainly be claimed by this Society, for one was held in its rooms in the year 1761, when the machines which had gained prizes from the Society were exhibited, and from that may be traced the regular series of the exhibitions of inventions of select specimens of British manufactures, which, as developed in the year, 1846 were the immediate precursors of the great Exhibition of 1851.

In my opinion the 1851 Exhibition was the result of two distinct influences, the one emanating from France and the other which, under the auspices of this Society, had been developed in this country. I do not wish to-night to repeat the history which should be well known to every member of this Society. I mean the part played by its President, Vice-Presidents, Council, and members in the original proposal, and in the subsequent successful carrying out of that great first international exhibition. I have lately perused again the minutes of the years 1845 and 1849, which establish beyond all question that the idea of that great exhibition originated with members of this Society, was discussed in a practical manner on many subsequent occasions, and that the ultimate plan was the development of the resolution and action taken by the Society and its members. How thoroughly the idea was taken up by the President, the late Prince Consort, and how much his decision that the exhibition should be international, in the interest that he throughout evinced in the whole proceedings led to its success, has been well told elsewhere.

When, in the year 1862, the time seemed ripe for another exhibition, it was the Society of Arts which again took up the proposal, and by the establishment of a large guarantee fund, rendered its realisation possible. And with the series of exhibitions suggested by Sir Henry Cole in place of the third great international exhibition, which series commenced in 1871 and lasted until 1874, the Society was closely connected. It published the reports, its *Journal* was the official organ, and on many occasions the Exhibition Committees were appointed by, and did their work through, the agency of the Society. With the more recent exhibitions held at South Kensington, it has had an equally close connection. The committee meetings of the Executive Councils of the Health and Inventions Exhibitions were held at these rooms, and, with the permission of the Council, the Secretary of the Society was allowed to undertake important duties in connection with the executive department of both exhibitions. With regard to the Colonial and Indian Exhibitions, the Society undertook the duty of preparing the published reports, and its members were actively engaged in the work of the various sections. Nor is it in exhibitions in England alone that the Society has taken its share. Its assistance rendered to the Commissioners of the Vienna Exhibition in the year 1873 is acknowledged in the report; and it inaugurated a movement for sending artisan reporters to the Paris Exhibitions, both of 1867 and again in 1878, on each occasion publishing a most useful and valuable series of reports as to the result of these visits.

I may be pardoned if for one moment I venture to suggest that my colleagues on the Council are entitled to the confidence of the Society, and are fully qualified to perform those important duties which are necessary to be performed in order to secure efficient representation of British interests at the coming exhibition. If any one should have a doubt

on this matter I would only refer him to the list of names. There is no higher authority on this subject than Sir Philip Cunliffe-Owen. Sir Edward Birkbeck and Sir Frederick Bramwell acted as the most efficient chairmen, the one of the Fisheries Exhibition and the other of the Exhibition of Inventions and Music, while the Duke of Abercorn acted as vice-chairman of both the Health and the Inventions Exhibitions. In fact, I think it may fairly be said that there is scarcely one of the members of the Council of the Society of Arts who has not been personally connected with the active work of exhibitions.

And now I would for a few moments occupy your time by a reference to the coming exhibition in Chicago, the duties of the Society in relation to it, and the advantages which the Council believe are likely to result to the British people from and through an efficient representation there. After the extraordinary success of the French Exhibition of 1889, it was thought by many that no other international exhibition could equal, far less eclipse, that magnificent display. Now there is, in fact, no finality in these matters. Speaking of the French Exhibition of 1867, the late Sir Henry Cole, in his report, expressed the distinct opinion that it would be impossible to surpass it; and that it would be never worth while any more to try and hold a single great exhibition; and yet no one will deny that the Exhibition of 1889, from the point of view of interest, far surpassed its predecessor.

America, however, knows no such word as finality; and the citizens of the United States would be unworthy of the traditions of their immediate forefathers had they allowed the challenge to have remained unmet, that they could not equal, and, probably surpass, the efforts of other nations. Accordingly, the occasion of the 400th anniversary of the discovery of America by Columbus was taken as the occasion for the holding of a great Exhibition in America.

I am here almost tempted, parenthetically, to make an observation. You will of course note that I am leading up to an appeal to the members of the Society of Arts to interest themselves, for reasons which I will in a few words venture to put before you, in the great Exhibition to be held in Chicago in 1893. Do not for one moment suppose that I mean to suggest that we here in the old country, in Great Britain, have attained finality in this matter. I look forward with hope to an Exhibition, not many years hence, which may take place again on some spot in the vicinity of this great metropolis, in which all previous exhibitions elsewhere in the world may also be rivalled or surpassed. That is a subject which will be dealt with I trust by some future Chairman of Council, and I will not deprive him of the pleasure of having an unbroken and undisturbed field.

Into the discussion as to the place to be chosen I will not here enter, as it belongs to the region of past history, the discussion of which is not of any particular advantage to members of the Society. Suffice it is to say that between the rival claims of New York, St. Louis, and Chicago, I may be allowed to express the opinion that the American people have exercised a very wise discretion in recognising the enormous advantages of the position of Chicago; and a firm belief that every feeling of rival interest has long since disappeared, and that the people of America have determined that the World's Columbian Exhibition of 1893 shall be, in every sense of the word, the greatest international exhibition the world has ever seen.

During the vacation the Council have sent their Secretary, Sir Henry Trueman Wood, who has, as you all know, a very large experience of exhibitions, in company with Mr. Dredge, a member of the Council, in a visit to Chicago, in order to obtain the best information upon all matters of interest to exhibitors or others likely to visit the exhibition in 1893, and I would refer the members of the Society to the very excellent paper read by Mr. Dredge, in the course of last session, and the equally, or I think I may say the still more valuable report of Mr. Dredge and Sir Henry Wood, which appeared in the *Journal* of the Society on the 23rd of October last. I have also the gratification of being able to announce that the subject is to receive still further notice in a paper to be read by Mr. Dredge on Wednesday, December 9th next. For myself, I would only say that situate as Chicago is, as the centre of a numerous population, the focus and terminus of nearly every great railway from every quarter of the States, the principal port on the great lake and canal system of America in connection with the Mississippi and the Gulf of Mexico, I do not see how it is possible that any better site for a successful exhibition could have been chosen.

With regard to the Exhibition itself, as I have already said, I do not wish to repeat what

can be gathered with greater advantage from the paper and report to which I have alluded; but it may be of interest to my hearers to know that Jackson-park, in which the Exhibition is to be held, is almost as large as Hyde-park, and that the whole of its vast area will be devoted to buildings appropriated to the various purposes of the Exhibition. Much more I could add with reference to the progress of the buildings, the accommodation to be afforded, and other particulars respecting the Exhibition, but upon those subjects I recommend the attention of all to the publications of the Commission and to the papers, in which full particulars can be found, but on behalf of the Commission I would earnestly appeal to the members of the Society to consider the extreme importance to British subjects and British industry, that the manufactures and art productions of the United Kingdom and the British Empire should be worthily represented.

Chicago will be visited not only by Americans and citizens and residents in the United States, but by the merchants and industrial classes of all nations. There is no doubt whatever that enormous numbers of visitors will come from South America. Efforts have been made by American traders, and possibly by the American Government—efforts which, from their point of view, we must regard as legitimate, to divert to the United States some portion of the great trade which has existed for so many years between South America and England. Americans, not unnaturally, consider that the Exhibition will afford an opportunity for furthering this policy; but, if so, of what immense importance it is that to these South American visitors should be shown the fact, by ocular demonstration, that the manufactures and products of British commercial industry maintain their position of equality, and, in many cases, of superiority. Again, the opening up of routes to the West will undoubtedly lead to very large numbers of Australians, Chinamen, and Japanese visiting the Exhibition, and it is obvious that a defective exhibition of British industry must have the effect of losing for British trade custom and prestige in those countries. In the race for success one cannot blame those who fight for themselves, and it must be remembered that a fine display of British goods would attract custom not only to the particular exhibiting firms, but to British industries generally; and it is for this reason that I would commend to the consideration of exhibitors the importance of forming collective exhibits representing the various branches of the industries of these countries.

I may be asked what class of exhibits will specially appeal to visitors to this Exhibition. I would reply, any of those productions which conduce to the happiness, comfort, health, and amusement of civilised races. At Chicago and in many great cities of the West, there is rapidly springing into existence a wealthy class who are only beginning to acquire the ideas of luxury and refinement. Large and magnificent houses are the natural outcome of the successful career of the traders in these young cities. From the point of view of artistic decoration, they must turn, or be led to the cultivated and developed tastes of the older European nations; and the same observation applies, in a marked degree, to the exhibition of works of art. The British school of painting is far less known in America than it deserves to be—much less than the French school—and there are hundreds, nay, thousands, who are willing and likely to expend large amounts in pictures and works of art, both for the decoration of their own houses, and also for the ornamentation of public buildings; and, with the little scope and market that now exists in the United Kingdom for the productions of English art—though this may be considered as putting the matter on rather a low platform—I earnestly commend to those interested in the arts of this country—both painting, sculpture, and drawing—the importance of the British nation being well represented in the Art Section. That the British exhibitors at Chicago will be welcomed in a way in which they would be received in no other country in the world is certain. Despite what may be said to the contrary, there is no country where Englishmen are so cordially welcomed or so well treated as in America, and no country in which English opinion, or the action of England, is so carefully watched or so highly regarded. I am in a position to state that the other European nations and other nations of the world will contribute to the Chicago Exhibition, at least to as large an extent as they have to any other undertaking of the kind. Practically, all the European countries have already announced their intention of being represented. Germany will probably fill a larger space than her exhibitors have ever before filled at an international exhibition. French art and French industry will be largely represented, and although it is yet early to speak about the exhibitors from Great Britain,

I am already in a position to state that, from the applications received, the Council entertain no doubt that the industries of the United Kingdom should take as prominent a place at Chicago as they have filled on all previous occasions when great international exhibitions have been taking place. I hope and have every reason to believe that our great Indian Empire will be fitly represented, and though my information does not enable me to speak positively as to the action of the British colonies, the Commissioners hope soon to be able to announce that the Court of the mother country will be in close proximity to the Courts containing the productions of Canada, Australasia, and British Africa, and that the British colonies will be represented (at least, I trust so) almost to as large an extent as at that magnificent Colonial Exhibition at South Kensington in 1886.

Before I conclude, I desire to read to this meeting a passage from a speech somewhat long, but yet which, when I came across it the other day in preparing for this address, occurred to me to be so good and so useful that I could not to any advantage curtail or cut out a single word of it. I will read this passage to you; I will then tell you whose words they are, and I will endeavour, in my concluding observations, to point one or two remarks founded upon the argument used in this passage:—

"Gentlemen, I conceive it to be the duty of every educated person closely to watch and study the time in which he lives, and, as far as in him lies, to add his humble mite of individual exertion to further the accomplishment of what he believes Providence to have ordained. Nobody, however, who has paid any attention to the particular features of our present era, will doubt for a moment that we are living at a period of most wonderful transition, which tends rapidly to the accomplishment of that great end to which, indeed, all history points—the realisation of the unity of mankind. Not a unity which breaks down the limits, and levels the peculiar characteristics of the different nations of the earth, but rather a unity the result and product of those very national varieties and antagonistic qualities. The distances which separate the different nations and parts of the globe are gradually vanishing before the achievements of modern invention, and we can traverse them with incredible ease, the languages of all nations are known, and their acquirement placed within the reach of everybody; thought is communicated with the rapidity and even by the power of lightning. On the other hand, the great principle of division of labour, which may be called the moving power of civilisation, is being extended to all branches of science, industry, and art. Whilst formerly the greatest mental energies strove at universal knowledge, and that knowledge was confined to the few, now they are directed to specialities, and in these, again, even to the minutest points; but the knowledge acquired becomes at once the property of the community at large. Whilst formerly discovery was wrapt in secrecy, the publicity of the present day causes that no sooner is a discovery or invention made than it is already improved upon and surpassed by competing efforts; the products of all quarters of the globe are placed at our disposal, and we have only to choose which is to be the best and cheapest for our purposes, and the powers of production are intrusted to the stimulus of competition and capital. So man is approaching a more complete fulfilment of that great and sacred mission which he has to perform in this world. His reason being created after the image of God, he has to use it to discover the laws by which the Almighty governs His creatures, and by making these laws his standard of action to conquer Nature to his use—himself a divine instrument. Science discovers these laws of power, motion, and transformation; industry applies them to the raw matter which the earth yields us in abundance, but which becomes valuable only by knowledge; art teaches us the immutable laws of beauty and symmetry, and gives to our productions form in accordance with them. Gentlemen, the Exhibition of 1851 is to give us a true test and a living picture of the point of development at which the whole of mankind has arrived in this task, and a new starting point from which all nations will be able to direct their own further exertions. I confidently hope the first impression which the view of this vast collection will produce upon the spectator will be that of deep thankfulness to the Almighty for the blessings which he has bestowed upon us already here below, and the second, the conviction that they can only be realised in proportion to the help which we are prepared to render to each other, therefore, only by peace, love, and ready assistance, not only between individuals, but between the nations of the earth."

That is a long quotation, but I think everyone who has followed it will agree with me that it is a quotation worth recalling to the mind of this Society. The words are taken from an address of the President of this Society in the year 1850, the late Prince Consort; and I would desire with all seriousness and all earnestness, as for the moment, and for the moment only, the mouthpiece of the Council of this Society, to point out to you the remarkable prophecies which are contained in these utterances, and with what truth they have embodied precepts which we ought to follow to-day. The late Prince Consort spoke of the destruction of distance. Why! what may

have seemed wonderful in the year 1850, has as you all know, been surpassed in the year 1891. Since then, the dreams and romances of the novelist have been proved to be not only realities but to be surpassed by actual facts. And do I refer to the rapidity of communication? Why you know perfectly well that not only in matters which affect the interests of nations, but in any subject which is exciting the attention of any large number of inhabitants of any civilised nation, no sooner has a publication been made than in a few seconds, sometimes in advance of the time at which the utterance has been made, it is wafted to the ends of the world by the electric wire, and becomes the topic from which other demonstrators take their starting point at the other end of the world. What does this point to? I remind you again of the remarkable sentence that the blessings bestowed upon us by this development, the result of science, the result of the diffusion of useful knowledge, can only be developed to the fullest degree, to the happiness of the greatest number, by each one being prepared to render to each other ready assistance, not only as between individuals but as between the nations of the earth. Many may think—nay, I know many have thought—though I hope and believe that that has almost entirely passed away—that, owing to commercial questions which have arisen in America, it might not be worth while for British traders to be anxious and keen that an exhibit worthy of the British nation should be there displayed. I believe most heartily that there was never any more mistaken notion. I believe there is nothing that the Americans would be more likely to appreciate than the sense that, whatever temporary disadvantages British commerce and British trade may have laboured under, still there was sufficient good fellowship, sufficient loyalty to the interests of mankind as apart from the interests of a particular nation, to lead the great manufacturers of this great country to determine that they would be worthily represented. But surely there is a higher, a loftier principle embodied in these noble observations, which, if they were true in 1850, are as true in the year 1891. Surely we must see that one result of this great Exhibition, if it does not lead at once to that universal peace which was the dream and aspiration of some of the founders of the Exhibition of 1851, yet must tend to draw closer together the bonds of friendship between the civilised nations of the earth. It must tend to make thinking men feel that they are members of one family, and that though they may be born under a different clime, and under circumstances dependent on their being resident in different parts of the earth, yet still in the cause of common humanity, in the cause of civilisation, it should be the aim of every thinking man to promote that universal feeling of good will which must ultimately bind and draw closer together all the nations of the earth. I know that individual members of the Society cannot do much; but, on the other hand, there are many members who can do a great deal. The Council has undertaken a work which they conceive to be a great work: they have undertaken a task in which they ask for the co-operation and support and assistance of all the members of the Society, extending, as we know they do extend, to every quarter of the United Kingdom, and I might say to every part of the civilised world; and I trust and believe that the appeal made in these few words from me will not be in vain. I do ask that you will appreciate and understand the work the Council have undertaken, and that you will, through your advocacy, through your agency, and through your instrumentality, do your best to supplement and assist in that work, and make the British Section of the great Exhibition at Chicago worthy of the great nation of which you are proud to be members.

Sir Richard Webster then proceeded to present the medals awarded by the Council for papers read during the last session, in accordance with the following list:—

At the Ordinary Meetings:—

To J. F. GREEN, for his paper on "Steam Lifeboats."

To A. G. GREEN, C. F. CROSS, and E. J. BEVAN, for their paper on "Photography in Aniline Colours."

To CARMICHAEL THOMAS, for his paper on "Illustrated Journalism."

To Colonel Sir CHARLES WILSON, K.C.B., K.C.M.G., F.R.S., for his paper on "Methods and Processes of the Ordnance Survey."

To A. P. LAURIE, for his paper on "The Durability of Pictures painted with Oils and Varnishes."

To Prof. WILLIAM ROBINSON, for his paper on "The Use of Petroleum in Prime Motors."

To Prof. J. J. HUMMEL, for his paper on "Fast and Fugitive Dyes."

In the Indian Section:—

To B. H. BADEN-POWELL, C.I.E., for his paper on "The Indian Village Communities, with Special Reference to Modern Investigation."

To THOMAS WARDLE, for his paper on "The Use of Tussur in European Textile Manufactures."

To CHARLES L. TUPPER, B.A., for his paper on "The Study of Indian History."

In the Foreign and Colonial Section:—

To Sir EDWARD N. C. BRADDON, K.C.M.G., for his paper on "Recent Development of Tasmanian Industries."

To Sir THOMAS WADE, G.C.M.G., K.C.B., for his paper on "China."

In the Applied Art Section:—

To WILLIAM SIMPSON, for his paper on "Lithography: a Finished Chapter of Illustrative Art."

To G. T. ROBINSON, F.S.A., for his paper on "Decorative Plaster Work: Modelled Stucco Work."

With regard to the first medal, Sir Richard remarked on the painful lesson we had recently learned as to the necessity for more efficient lifeboats, and on the satisfaction which all must feel at seeing a getleman so eminent in connection with the mercantile marine as Mr. Green devoting his abilities to this matter.

The paper on "Photography in Aniline Colours" he had already referred to.

Mr. Carmichael Thomas had given a most interesting paper on "Illustrated Journalism," and those who, like himself, had had the pleasure of inspecting the machinery and arrangements at the *Daily Graphic* office must have been very gratified at seeing the wonderful developments which had been effected in this direction.

Sir Charles Wilson, who was unfortunately unable to be present, was specially employed in Egypt in 1882-83; he was at the head of the Intelligence Department of the Nile Expedition in 1884; was Director of the Survey of Ireland in 1883-84, and since 1886 had been Director-General of Ordnance Survey.

Mr. A. P. Laurie, to whose paper he had already referred, was a Fellow of King's College, Cambridge, and Lecturer at Toynbee Hall; and he was glad to be able to announce that the Council had selected him to give a course of Cantor lectures in the coming session.

The Society had often been charmed by the papers and lectures of Professor Silvanus Thompson; and Professor William Robinson, who took the next medal, was formerly an assistant of his at the Finsbury Technical College, and no doubt largely benefited by his connection with it. He was now Professor of Engineering at the University College, Nottingham.

Professor Hummell's paper he had already noticed.

The name of Mr. Baden-Powell was well known as connected with the very distinguished gentleman who at present represented British interests in connection with the seal industry in Behring Straits, and if he mistook not, the recipient of the medal was also eminent in connection with the subject on which he had read the paper for which the medal was awarded.

Mr. Thomas Wardle's name was very familiar in the Society, and he was distinguished by his efforts for the improvement and advancement of the silk industry generally, and especially with a material which was for a long time considered of very low value if not almost a waste product—Tussur silk. He was chairman of the silk culture department in the Colonial and Indian Exhibition and President of the Silk Association for Great Britain and Ireland. Many people thought silk was produced by only one insect, but Mr. Wardle had given a list of some eighteen or nineteen different insects from which it might be obtained.

Mr. Charles Tupper had been for some time Chief Secretary to the Government of the Punjab, and had made a special study of Indian records in connection with the subjects dwelt upon in his paper.

Passing from India to the Colonies, he again came to a gentleman bearing a very well known name, Sir Edward N. C. Braddon, who, he believed, was a near relative of the lady whose imaginative powers had delighted so many readers.

Sir Thomas Wade, in his paper on "China," brought to bear no ordinary experience. Originally in the army, his career in China commenced in 1843; and, from 1871 to 1883, he was Envoy Extraordinary and Minister Plenipotentiary, as well as Chief Superintendent of British Trade in China. It was a great honour to the Society that a paper should have been contributed to its proceedings by so distinguished a man.

Mr. William Simpson, who came next, had claims of a different kind. Originally a practical lithographer, he was the author of one of the finest specimens of book illustrations in lithography, and was also special correspondent of the *Illustrated London News* on many important occasions since the Crimean war.

Mr. G. T. Robinson, who, unfortunately, was not present that evening, was one of the earliest to introduce from Italy the use of various kinds of artistic plaster work, which flourished to such a high degree in the

seventeenth and eighteenth centuries, but which, in the early part of this century, had almost disappeared in connection with house decoration.

Sir FREDERICK BRAMWELL, F.R.S., said it had been his privilege to hear many addresses by chairmen of that Council, and of each he had felt inclined to say that it was as good an address as ever he had listened to. Certainly he was not going now to depart from that time-honoured and, as a rule, truthful statement. They had had from Sir Richard Webster a most useful and most earnest address, which no one could have heard without feeling that he had stated forcibly and truly the useful work of the Society, now about a century and a third old; that he had urged very appropriately the importance of that work being continued, and that he had very properly referred to the honour conferred upon the Society by the Council being appointed the Royal Commissioners for the Chicago Exhibition. In reference to that matter, he would ask all present to remember the earnest words which the chairman had used—well qualified to accompany the noble extract which he had read from the Prince Consort's speech in 1850. Sir Richard Webster was not merely addressing those present, but through the Press the whole of England and a large number of English-speaking people throughout the world. He had called attention to the improvements which had been made in the rapid transmission of intelligence, and, thanks to that improvement, it was not improbable—nay, it was almost certain—that to-morrow the gist of those words would be read in Chicago itself, and that they would there see that we in this country were determined to do our very best—under the guidance of the Commission, presided over by the Prince of Wales, but the real working head of which was Sir Richard Webster—to make the Exhibition a success, so far as the United Kingdom was concerned. He need say no more in proposing that the best thanks of the Society be given to Sir Richard Webster, Chairman of the Council, for his address.

Lord ALFRED CHURCHILL cordially seconded the motion. He remarked that many of the members were probably unaware of the great services which Sir Richard had rendered to the Society since he had been connected with it, and especially since he had occupied the chair. It was mainly due to his exertions and influence that the Council had been honoured by being appointed the Royal Commission for the Exhibition, the only instance of the kind, he believed, which had ever occurred. He hoped that he would continue to hold office until the close of the Exhibition.

The motion having been carried unanimously,

Sir RICHARD WEBSTER, in reply, said he was exceedingly grateful for the kind words spoken by his old friends, Sir Frederick Bramwell and Lord Alfred Churchill, and still more for the kind reception given to the proposal. It was no light task to undertake the duties of Chairman of the Council of that Society. As he had said last year—and he felt it even more to-day—looking back on the great men who had preceded him, many of whom were fitted, from their personal knowledge and research, to guide and instruct the Society on many branches of modern science—it seemed almost presumptuous for a lawyer to fill such a place. But he had brought to bear upon the work connected with the Society all the energy and all the powers of application with which God had been pleased to endow him, and at any rate he had given them the best he could. If after his year of office was over the Society thought he had not unworthily filled the position, he and his family would always be proud of his connection with it.

Miscellaneous.

TURIN COMMERCIAL MUSEUM.

The following communication of the Director of the Museo Merciologico at Turin, asking for the gift or loan of specimens of the products of the United Kingdom, for exhibition in the Museum, has been received from the Science and Art Department:—

Museo Merciologico di Torino,
Exposizione Permanente di
Materie prime del Commercio e dell' Industria,
Corso Palestro, 1bis.

Torino, 21 Août, 1891.

La Ville de Turin a ouvert depuis plusieurs années un Musée Merciologique ou Commercial, fondé par moi-même en 1860. Dans cette exposition permanente et gratuite peuvent être dignement représentés tous les produits naturels et manufacturés de chaque pays du monde.

Parmi eux l'on désirerait y voir figurer les matières premières des industries et les produits du sol de ce Royaume Uni.

Les noms des Exposants-Donateurs seront inscrits dans un album spécial et sur des tableaux à l'entrée du Musée.

Avec l'espoir d'une réponse favorable, je vous remercie à l'avance pour tout ce que vous voudrez bien faire au profit de cette institution d'utilité internationale, et vous prie d'agréer, Monsieur le Ministre, l'expression de mes sentiments de haute considération.

Votre trés-dévoué serviteur,
Le Directeur du Musée,
(Signed) PROFESSEUR G. GARNAUDON,
Conseiller Com. de la Ville de Turin.

A Son Excellence
Monsieur le Ministre
de l'Agriculture et du Commerce,
pour la Grand Bretagne et l'Irlande.
à Londres (Angleterre).

PRODUCTION OF IRON ORE IN THE UNITED STATES.

It appears from a recent bulletin issued by the United States Census Office, that during the year ending December 31, 1889, the production of iron ore in that country amounted to 14,518,041 long tons, which was contributed by twenty-six States and two territories, and this output represented a value at the mines of $33,000,000, an average of $2·30 a ton. Michigan was by far the largest producer of iron ore in the census year 1889, a total of 5,836,169 long tons having been mined, the value of which was $15,800,521 at the mines. The amount from Michigan therefore represents 40 per cent. of the total, while the aggregate value is 47 per cent. of that of the entire country. The credit of holding second rank lies between the States of Alabama and Pennsylvania, the former having a slightly greater output than the latter. The production of Alabama in 1889 was 1,570,319 long tons, valued at $1,511,611. These figures represent 10·8 and 4·5 per cent. respectively of the total output and value. Pennsylvania closely follows Alabama, its output being 1,560,234 long tons, valued at $3,063,534, 10·7 and 9·2 per cent. respectively of the total output and value. The other State which produced over 1,000,000 tons in the census year was New York, which is credited with 1,247,537 long tons, valued at $3,100,216. These four States, therefore, produced a total of 10,234,259 long tons, or 70·5 per cent. of the entire output of the iron ore mines of the United States, while the value of the ore amounts to $23,475,882, or 70·4 per cent. of the total valuation.

TECHNICAL EDUCATION AT ST. ETIENNE.

For the past twenty years the French Government has devoted a great deal of attention to the education of the people. National schools, says the United States Consul at St. Etienne, have been opened in almost every village, and the instruction given is of a very useful order. Besides the primary schools, there are superior schools where diplomas for "great merit" may be obtained. These latter, however, are only attained by pupils belonging for the most part to the middle classes, who intend to become teachers or governesses in public or private institutions, or by those who have no other purpose in view than of being considered fairly well educated. As the working classes, on the other hand, cannot afford for their children the expenditure of time and money which a course of these higher schools involves, they are obliged to withdraw them when they have received the certificate of elementary education which is generally given to children between the ages of twelve and thirteen. It is for this poorer class that towns of importance throughout France have established well equipped schools where various trades are taught gratuitously, both practically and theoretically. St. Etienne being one of these important cities, with 130,000 inhabitants, possesses a model, well organised, and successful technical school. The technical institution of St. Etienne was built in 1885 at a cost of £23,120. The school has three hundred students, and the trades taught are weaving, dyeing, sculpture, iron founding, cabinet making, &c. The apprenticeship is four years in duration, and the institution is free. At the end of four years, a certificate of aptitude is given, which enables the pupil to obtain a situation in the line of industrial labour which he had chosen. The work of the school begins each day at seven in the morning, and ends at seven in the evening. The school is composed of two buildings. The first is reserved for general education, and the second contains the different workshops, occupying 1,400 square metres of surface. The fitting up of these workshops is very complete, and comprises vices, lathes, boring, planing, and other machines, forges, anvils, steam hammers, carpenters' benches, circular saws, weaving machines of every variety, and all the accessories of the dyeing industry, as well as important collections of chemical and physical apparatus. The whole building is lighted by electricity. The lectures are of two kinds. The first are common to all students of the same year, and embrace general subjects, while the second are exclusively technical, and are special to each section. In the first year, the students pass through all the workshops to be initiated into the proper handling of the different tools, whether of iron or wood. After this period, the boys are classed according to their tastes, desires, and aptitudes. They work at manual labour three hours daily during the second year, four hours in the third, and five in the fourth. and last year for the first six months, and seven hours during the last six months, in order to accustom them to the burden of a day's work. During this period, also, great attention is paid to the teaching of the theory of the different trades, that is to say, the fitters are taught to trace and cut out cog-wheels, and the carpenters to design and execute a certain number of apparatus, such as stairs of different variety, shutters, balconies, &c., on a reduced scale. The weavers, besides being taught thoroughly all the details of the loom and its working, receive special lessons in book-keeping, legislation, commercial geography, and are taught one of the modern languages. Very careful attention is paid to design. The apprentices at all the trades are obliged to follow the instruction given on this subject, which is rightly considered of the greatest importance in the school. Designs of various kinds are executed by the more advanced sections, and every year an exhibition of the work of the boys is held. Consul Loomis says that the results of this school have been most excellent, and he has been informed that, as a rule, its graduates become self-supporting members of society in a very short time.

PRODUCTION OF OLIVE OIL IN THE MARITIME ALPS.

The olive covers about 70,000 acres in the Department of the Alpes Maritimes, and it yields a revenue of over £400,000. The United States Consul at Nice says that there seem to be but two species of olive trees in the south of France, the oleaster (wild olive), having a kind of thorn, very short leaves, and producing only a few small berries, which neither the *dacus* nor the boring caterpillar will attack; the sativa (cultivated olive) is another description, which produces a large fruit. Seedlings of the sativa sometimes deteriorate, so as not to be distinguished from the oleaster. There are several varieties of the above, the principal of which are the following:—The *blanquetier*, which has a light green foliage, bears a small fruit, and produces oil abundantly. The *blavier* is very hardy; its fruit is oblong, and comparatively large; the pulp is coarse, and the oil deeply coloured. The *arabanier*, or *araban*, is a tree hardier than either the *blavier* or the *blanquetier*, and the oil produced from the fruit is of ordinary quality. The *calletier*, which is also known by the characteristic name of *pendoline*, thrives best in dry soil, and, at its best, its fruit sells for a third more than others for mixing with poorer qualities. Other good varieties for oil are the *nirvana*, the *auriola*, the *nicoise*, the *blanche*, the *roberon*, the *negrette*, the *caillan*, &c. The olive tree flowers every year; and some growers advocate an attempt to gain a yearly crop, but the majority are content to try to get a good crop every two years. The trees bud in May, and flower in June. Olives, to be preserved green, are picked in September; those destined for oil, from November until the following May; but the best results, to crop and tree, seem to follow harvesting, near midwinter, when the olive is black, though oil made from olives gathered as late as Febrnary and March is preferred for its keeping properties. The farmers in the neighbourhood of Nice spread sheets under the trees, and knock the fruit down with poles, injuring both fruit and tree in so doing. The harvest is gathered largely by Italian women, who come into France for that purpose, and they are paid by the quantity gathered, boarding themselves. The olives being gathered, the farmer either takes them to the mill at once, or spreads them in the sun or granary to dry out some of the moisture. The mill in use at the present day to crush the olives differs little from those used for centuries. The olives are poured into an enormous stone bowl, from the centre of which rises a large wooden shaft crowned with a large wheel; in the rim of the wheel, pointing downwards and regularly spaced, are strong oak pegs for cogs. These pegs meet similar pegs or cogs in the power wheel which is turned slowly by an overshot water-wheel. Attached to an upright shaft, forming an acute angle with its lower end, is a large millstone, exactly the shape of a large grindstone, the edge bevelled to match the slightly concave bottom of the great bowl, and from the side of the upright shaft opposite to the great millstone, on the end of a short horizontal shaft, is a scraper which fits the inner side of the bowl. When the mill starts the olives in the bottom of the bowl are crushed by the stone, these forced up the inner sides of the bowl as the great stone revolves, are scraped off and drop back under the stone until the mass is reduced to an oily paste. This paste is packed into woven grass bags, which are then taken to the presses; these presses are simply rough heavy frames fitted with large screw presses worked by hand. The bags are then piled up on a wide oaken slab forming the bottom of the frame, the presses are screwed down upon them with a hand-bar, the oil drains into tubs placed to receive it, when boiling water is poured over the bags to help the flow and joins the oil in the tub. The oil rising to the surface of the water is skimmed off with large tin skimmers. A mill has lately been invented, says Consul Bradley, by the director of the agronomic station of Nice, which, as it crushes the pulp, extracts the stone and throws it out, thus allowing the oil of the pulp, the true virgin oil, to be obtained fiom the press without any admixture of that obtained from the stone or kernel. In preparing virgin oil, which, as it requires so much care and attention to prepare, is difficult to obtain, the following system is adopted. Olives are taken when only three-quarters ripe, and they are selected free from any blemish. They are taken, immediately after they are gathered, to the mill, where they are but slightly crushed, so that the pulp alone comes in contact with the millstone; the seed must not be touched, for though the kernel contains a certain quantity of oil, it is rather acid, and has not so fine a taste as the oil from the pulp. This pulp having been crushed without the addition of water, is gathered in a heap, the centre of which is made hollow in the shape of a funnel. The oil flows by itself from the inner sides into the centre of a reservoir, from which it is taken with a large ladle. The oil so prepared is greenish in colour, its perfume is exquisite, and it can be kept for many years. For oil of the first quality, called "cannon oil," the olives are placed in the mill without addition of water, if the fruit is freshly gathered. The oily paste is placed in bags, made of clean esparto, and put into the press. To obtain second quality oil, and to extract from the pulp all the oil which it contains, the contents of the bags are thrown into a vat full of cold or warm water; the whole is well stirred up, the broken fragments of the seeds fall to the bottom, while the pulp floats, and the latter is gathered and replaced under the press. After all the usual means of extracting the oil from the pulp have been employed, 10 per cent. of oil can still be obtained by using bisulphide of carbon. After the oil is extracted, the skins and refuse are employed in heating boilers, the muddy substance found at the bottom of the most inferior quality of oil is used as manure; and, last of all, the broken stones, or *grignons*, make a very excellent fuel, which has the

advantage of not giving off any carbonic acid gas, as charcoal does. Consul Bradley says that fraud is found in the oil mills as in other places. Should the olives be mouldy, which often happens when they have been gathered or kept in bad condition, the bad taste is hidden by adding leaves of wild olive trees to the pulp. Some olive growers even go so far as to throw seed oils over the pulp while it is being ground, so as to get a perfect blending with the new oil. To keep the oil in good condition requires great care and attention. The clear oil is separated from the turbid at once, for the longer the oil remains on the lees the more apt it is to contract a rancid or a bad odour. When the oil has been decanted several times, filtered through dry moss, carded cotton, sand, plaster, charcoal, &c., it is stored in a place which is sheltered both in summer from the heat, and in winter from the cold. The oil must be kept in vessels which close tightly, and are made of a substance on which oil has no action. These precautions are indispensable, for the effect of the air on oils is too well known not to be guarded against.

PRODUCTION AND CONSUMPTION OF VANILLA.

Paris, London, and New York are the markets of the world for Vanilla; after these, says Consul Knowles, of Bordeaux, that city occupies an important place. Great quantities of the bean are used in France. It is employed in making confectionery, ices, liqueurs, and cordials, and enters into the manufacture of perfumery. Vanilla is of Mexican origin, though found in almost every tropical country. It is a vigorous rind of the orchid species, about twenty to thirty feet in height, with heavy, oblong, sea-green foliage. It thrives in dense forests, where its branches entwine and interlace themselves with neighbouring trees. The stem is four-cornered, the flowers large, fragrant, and spikelike. It yields to cultivation. The greater part of the vanilla imported into France comes from her colonies—Guadeloupe, Madagascar (Sainte Marie), Mayotte, the island of Réunion and Tahiti. The production, in 1889, of vanilla in these colonies amounted respectively to 9,000, 19,000, 19,000 506,000, and 7,000 pounds weight. The vanilla tree begins to yield in its third year, and from thence to its thirtieth. The season commences in the month of April, and lasts until the middle of June. The beans are gathered in the green state, before maturity. There are two existing methods of curing manilla. In the first of these, the beans are laid in quantities on great cloths spread upon the ground, and exposed to the sun for a period of two months, or until they have attained a dark brown colour. They are then packed in bundles of fifty, and placed in tin boxes for exportation. The second method consists in attaching, by their inferior extremities, a number of the beans, and immersing the same in a vessel of boiling water, until they become white. They are then exposed for a few hours only to the sun, after which they are covered with a native fixed oil, usually that of the cashew nut. There are four qualities of vanilla, and these are determined by the length and size of the bean, it being found that the flavour and perfume are in direct ratio to their weight and measurement. In appearance the beans are slender and cylindrical, averaging about five or six inches in length, and half an inch in thickness. Within is a soft black pulp. The quality of the bean is further enhanced by the exudation of a certain needle-like crystal or effloresence which covers the surface of the fruit, and is called in French *vanille givrée*. The crystals are found to be almost pure benzoic acid. The imports of vanilla into France, which amounted, in weight, to 198,000 lbs. in 1880, exceeded 258,000 in 1889.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 23...Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. Mr. William Scott Morton, "Tyncastle Modelled Canvas and other Decorations."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. R. Adams, "The Title to Land, its Registration and Transfer."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. St. George Littledale, "A Journey across the Pamir from North to South."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Knight, "Spinoza: the Man and his System."

TUESDAY, Nov. 24...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on the papers by Messrs. Bamber, Carey, and Smith, "Portland Cement and Portland-Cement Concrete."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. H. Mitford Barber, "Perforated Stones of South Africa." 2. Mrs. S. S. Allison, "Notes on the Indians of the Similk'ameen, British Columbia."

WEDNESDAY Nov. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Silvanus Thompson, "The Measurement of Lenses."

Geological, Burlington-house, 8 p.m. 1. Prof. H. G. Seeley, "The Os Pubis of *Polacanthus Foxi*." 2. Prof. Edward Hull, "A Comparison of the Red Rocks of the South Devon Coast with those of the Midland and Western Counties." 3. Rev. A. Irving, "Supplementary Note on the Red Rocks of the Devon Coast-Section."

THURSDAY, Nov. 26...London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Boyd Dawkins, "The Spread of Commerce in Europe in Pre-historic Times."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Capt. H. R. Sankey and Mr. F. V. Anderson, "Description of the Standard Volt and Ampere Meter, used at the Ferry Works, Thames Ditton."

FRIDAY, Nov. 27....Juuior Engineering Society, Westminster Palace Hotel, S.W., 8 p.m. Presidential Address by Sir Edward J. Reed.

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Walter Clemence, "Modern Railway Carriages."

Journal of the Society of Arts.

No. 2,036. Vol. XL.

FRIDAY, NOVEMBER 27, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

TYPOLOGICAL MUSEUMS.

Attention is drawn to the alteration which has been made in the announcement of the Meeting for Wednesday, December 16. General PITT RIVERS will read his paper on "Typological Museums, as exemplified by the Pitt Rivers Museum at Oxford," on that evening; and Professor VIVIAN B. LEWES'S paper on the "Spontaneous Ignition of Coal" will be read at an early Meeting after Christmas.

Chicago Exhibition, 1893.

Under date of the 27th August, 1891, Her Majesty was pleased to issue a Commission to the Council of the Society of Arts, authorising them to act as Commissioners for the Universal Exhibition, which, pursuant to an Act of Congress, and in accordance with a Proclamation made by the President of the United States of America, will be held at Chicago from May 1st to October 30th, 1893.

The Royal Commission are now prepared to receive applications from artists, manufacturers, and others desirous of taking part in the Exhibition, to afford them all necessary information, and to offer them all available facilities which they may desire for this purpose.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

As the funds granted by H.M. Government will not suffice to defray all the expenses of the Section, it is necessary that they should be supplemented by payments from the exhibitors. A charge will therefore be made to each exhibitor, based on the amount of space occupied, and calculated on the following scale:—

	Per sq. ft. s.	d.
For spaces not exceeding 100 sq. ft. ..	5	0
For spaces exceeding 100 sq. ft. and not exceeding 200 sq. ft.	4	6
For spaces exceeding 200 sq. ft. and not exceeding 300 sq. ft.	4	0
For spaces exceeding 300 sq. ft. and not exceeding 500 sq. ft.	3	6
For spaces exceeding 500 sq. ft. and not exceeding 750 sq. ft.	3	0
For spaces exceeding 750 sq. ft. and upwards	2	6

The minimum charge will be £5.

It is not expected that the total receipts from all sources will more than suffice to defray the cost of an adequate representation of British industry; but should there be a sufficient surplus after the payment of all the costs of the Section, the Royal Commission will refund the balance *pro rata* with the amounts contributed by the several exhibitors. The amount produced by the payments of exhibitors will therefore be treated as a guarantee fund, to be expended if necessary, but if not, to be refunded to the contributors.

The Exhibition is situated in Jackson-park, within the southern limits of the city of Chicago. The principal buildings are devoted to the following main divisions:—(1) Fine Arts; (2) Manufactures and Liberal Arts; (3) Agriculture; (4) Machinery; (5) Electricity; (6) Mines; (7) Transportation; (8) Horticulture. In all these, space has been allotted to Great Britain, though it is expected that the principal British Court will be that in the Building of Manufactures and Liberal Arts, since the privilege has been conceded to this country of massing all or most of its exhibits together, should such a course prove desirable.

Exhibitors' goods will be transmitted direct in bond to Chicago, where the usual Customs examination will be made. Goods for exhibition only will not be liable to duty, but on goods sold the usual rates will have to be paid. Goods can be sold in bond, at prices independent of the tariff, the duties being payable by the purchaser.

The American railroad companies propose

to carry goods back from the Exhibition free, charging the usual rates for the outgoing journey. These rates, it may be noted, are low in comparison with those usual in European countries. It is hoped that special terms for Exhibition goods traffic may be obtained from the Atlantic steamship companies. Full information as to routes, traffic, rates, &c., will be provided in due course.

A limited quantity of steam and water power will be supplied gratuitously. Further supplies will be provided at a fixed rate. Countershafts, pulleys, belts, &c., must be provided by the exhibitor. Application for motive power must be made on special forms, which will be supplied on demand.

The general reception of articles at the Exhibition buildings will commence on November 1, 1892, and no articles will be admitted after April 10, 1893. Foundations for heavy machinery may be put in, and special constructive work commenced, as soon as the state of the ground and the buildings permits.

The Royal Commission are informed that the contract labour laws of the United States will not prevent exhibitors from importing foreign labour, or from entering into binding contracts with their *employés*. Further information on this head will be supplied on application.

Every person who becomes an exhibitor in the British Section thereby agrees to be governed by the rules and regulations laid down by the Exhibition Executive, or by the Royal Commission through its executive officer.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 25, 1891; Professor GEORGE CAREY FOSTER, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Baird, John, Knoydart, Isle Ornsay, N.B.
Brettell, J. Henry, 11, Portman-street, W.
Butterworth, William, United States Patent-office, Washington.
Patterson, Myles, Oriental Club, Hanover-square, W.
Proctor-Sims, Richard, M.Inst.C.E., Bhavnagar, Kathiawar, India.
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The paper read was—

THE MEASUREMENT OF LENSES.

BY PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

Often have I regretted that the resources at the disposal of the Technical College, Finsbury, did not enable its staff to organise and equip a proper laboratory for optical measurements, and for the standardising of optical instruments, in the same thorough and practical way in which they have now for more than ten years organised laboratories for electrical measurements. What Professor Ayrton did ten years back for the City and Guilds Institute, in organising a laboratory for electrical measurements, I have longed to do for optical measurement, believing that, when the opportunity should come, the work would be of as much benefit to the optical industries of London as the electrical laboratories of the City and Guilds Institute have been.

The exact measurement of optical quantities is no novelty: for in this branch of science precision has long reigned, if not in the lower branches of the industry, at least in the higher. And the laboratory methods of optical measurement are for the most part thoroughly worked out and known, though many of them unfortunately involve the use of expensive instruments and appliances.

An optical laboratory should possess the means of testing rapidly, accurately, and without too expensive appliances, such matters as the truth of plane surfaces, the curvature of curved ones, the focal powers of lenses, their aberrations and their aperture. It should have means of testing mirrors and prisms, as well as actual entire instruments. It should be able to state the results in terms available for future years by the employment of accurate fundamental standards.

With but one very small part of the subject of the work of the optical laboratory do I propose to deal to-night, namely, with the measurement of lenses. Lenses are used for many different purposes, and in varied functions and combinations. Measurements that would be important for some of these are utterly unimportant for others. For example, the condenser lenses used for magic lanterns are not wanted to be either aplanatic, achromatic, or rectilinear; their function being merely to collect the light which emanates from a certain luminous patch, and spread it as nearly equally as possible over the area covered by the trans-

parent slide, so that the whole is equally illuminated, and so that the light so transmitted shall be on the whole slightly convergent. To measure the aberrations or exact focal powers of such lenses would be a useless work.

However, it will be convenient at the outset to enumerate all the things which might be made the subject of measurement with respect to a lens or combination of lenses. These are no fewer than 18 in number:—

1. Diameter, or linear aperture.
2. Thickness, or length from pole to pole.
3. Focal power, or its reciprocal the focal length.
4. Position of principal focal planes.
5. Position of optical centres ("principal points" of Gauss).
6. Angular aperture.
7. Chromatic aberration.
8. Spherical aberrations, lateral and longitudinal.
9. Chromatic difference of the spherical aberration.
10. Loss of light by reflexion from surfaces.
11. Absorption of light in transmission.
12. Illumination of field, central and marginal.
13. Complaneity of focus (included in 7 and 8).
14. Degree of distortion of image (rectilinearity).
15. Cylindricity, or degree of astigmatism, including angle of axis of cylindricity.
16. Accuracy of centreing.
17. Definition in margin of field (involved in 7, 8 and 16).
18. Refractive indices of materials.

Now, of all these varied matters, there are but three with which the present paper will deal: namely, the focal power of lenses, and the position of their focal planes and principal points.

By focal power I mean, of course, that property on which their convergivity (positive or negative) depends, and on which in turn their magnifying (or minifying) action is dependent. It must be borne in mind, as a fundamental principle of elementary optics, that all that any lens or mirror (or combination of mirrors or lenses) can effect is to imprint a curvature on the wave-front of the light that enters it. If the wave is plane—*i.e.*, consists of parallel rays, to use the old language—then the lens prints a curvature, positive or negative, upon it by virtue of which its march is changed, and made convergent or divergent. If the wave before impinging on the lens is initially non-plane, but either convergent or divergent, then the lens will alter the curvature of the surface, the resultant curvature on emerging being simply the algebraic sum of the initial curvature and the impressed curvature.*

The focal power is the curvature imprinted by the lens on a plane wave, and is the reciprocal of the true focal length. It is appropriately expressed in terms of the proper unit of focal curvature, the *dioptrie*.† The proper numbering of lenses in dioptries has been an enormous gain in one branch of the optical industries—that of the ophthalmists—and it is much to be wished that other lenses than those of spectacles should also be henceforth described in the same way.

Another important step has been the introduction of the conception of focal planes—a conception to which the use of the photographic camera has doubtless contributed its share. Less fully recognised, but none the less important, is the conception introduced by Gauss as the result of his studies in geometrical optics, that the properties of any centred combination of lenses might be represented by a system of planes and points which are, so to speak, the characteristics of the equivalent lens. A lens can be considered as having a single optical centre only when it is infinitely thin, or at least of negligible thickness. All thick lenses and combinations of lenses have two optical centres, described by Gauss as the two "principal" points ("Hauptpunkte"), which are considered as the places where the axis intersects two "principal planes." These principal planes are at a certain distance apart, and equi-distant between the two principal foci

* All the ordinary formulæ of the text-books for lenses are more or less particular statements in symbols of this general rule: for example, the well-known formula

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$$

in which f is the focal length, and u and v the respective distances of two conjugate points serving as object and image. The reciprocal of a length *is* a curvature: so that this formula merely states that one curvature is the result of adding two other curvatures together. I have pointed this out in a paper in the *Philosophical Magazine*, in Oct., 1889.

† The *dioptrie*, originally proposed by Monoyer as the unit of focal power of a lens, is now in international use, having been formally adopted by the International Medical Congress at Brussels. It is a unit of curvature, and as such may be used for other purposes than focal powers—for example, to express the curvatures of surfaces. Unit curvature is taken as the curvature of a circle of one metre radius. Or a lens having a metre focal length is described in modern language as having a power of one dioptrie. A lens having half a metre as focal length has a power of two dioptries.

at the back and front of the lens. They possess certain properties most useful in the geometrical treatment of lens problems, and act as though the light, however obliquely it may be crossing the lens, were transferred straight from one to the other. The two "principal" points, or optical centres, possess the property that light proceeding from any direction towards the one of these points passes out from the lens combination as though it had passed through the other. Fig. 1 shows a

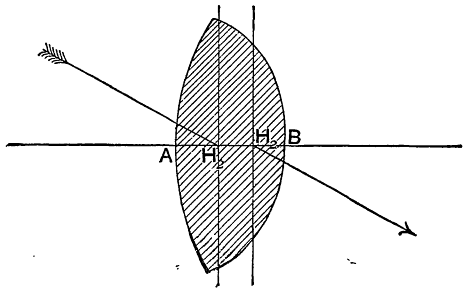

FIG. 1.

thick lens (in diagram), in which the two principal points of Gauss are marked H_1 and H_2, with the two principal planes drawn through them. These two points, together with the two principal foci, completely determine the action of the lens. When the positions of these four* cardinal points are known for any lens or lens-system, then all is known that is necessary for a complete discussion of the formation of images for all objects lying near the principal axis. The true focal length is the distance from either of the two principal planes to the corresponding principal focus; the back focus and the front focus being equidistant each from its own optical centre. But hitherto it has been found difficult to ascertain the position of the principal planes of a lens combination. Optical instrument makers generally have no information on the subject that they can furnish. They can tell us approximately the focal length, but they cannot, or do not, tell us the position of the optical centres or principal points from which this focal length is to be reckoned. Beginners in microscopic work, when they come upon an objective marked "¼-inch," expect to find that the object must be placed ¼-inch below the front surface of

* If the lens system is not bounded by similar media on its two faces—for example, if one side is bounded by air and the other by water—the two optical centres are shifted away from the two principal planes towards the denser medium, and are known as "nodal" points. In this case there are six cardinal points to consider.

the lens, and are often puzzled to find that the distance is perhaps only 1-10th inch. Naturally they ask the question, from what point does the maker measure his quarter of an inch? The correct answer is that the ¼-inch should be measured from the principal plane which corresponds to the front focus of the lens. But where this principal plane lies is never marked on the brass mount of the lens, though it ought to be. Again, the beginner often asks what is the correct way to reckon the true tube length of the microscope between objective and eyepiece. Must he measure from the lowest point of the eyepiece to the highest point of the objective, or how? The right answer is that the true distance between objective and eyepiece is not the mere length of the tube, but is the distance between the second principal plane of the objective, and the first principal plane of the eyepiece. But how is the unfortunate possessor of the instrument to measure this if the constructor has omitted to mark on the eyepieces and objectives the positions of the principal planes?

It is one of the purposes of this paper to describe an instrument for measuring lenses, and ascertaining the precise position of these principal planes. Therefore, a few more preliminary words about the principal planes and the two Gauss-points through which they pass, will be appropriate.

In ordinary single lenses, if not very thick in proportion to diameter, the distance between the two principal planes is approximately one-third of the thickness of the lens at its middle. Exact formulæ are given in various modern treatises on geometrical optics. In lenses that have their two faces of different curvatures the principal planes do not lie symmetrically between the two poles* of the lens, but are shifted toward the more highly curved face, or even beyond it. In plano lenses, whether convex or concave, one of the two principal planes is a tangent to the curved face. These matters are illustrated by the sketches in Figs. 2, 3, and 4 (p. 25).

If the positions of the four cardinal points are known for any two lenses separately, then, when the lenses are placed at any given distance apart, the positions can be found for the four cardinal points of the combination. The geometrical construction is very simple, and is illustrated in Fig. 5. Let h_1 h_2 be the

* I have used this term for years to denote the middle-points of the two faces of the lens, and find it very convenient.

two principal points of a lens, and f its principal focus for light passing through it to the right. Let $h'_1\ h'_2$ be those of a second lens, and let f' be its principal focus for light passing the other way. It is required to find the position of the principal points and of the principal focus of the equivalent lens. Consider any ray-path $a\ b$ parallel to the axis. Light travelling along from a will, after passing the principal planes of the first lens, turn towards f. Similarly, light passing the other way from b, after passing the second lens, will turn toward f'. These paths cross at o. Join oh_2 and oh_1; and draw $h_1\ x$ parallel to oh_2; and $h'_1\ y$ parallel to oh'_1. The planes xH$_1$ and

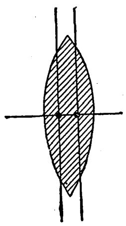

FIG. 2.

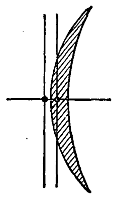

FIG. 3.

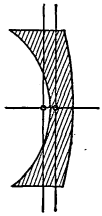

FIG. 4.

yH$_2$ drawn through x and y will be the desired principal planes. And the resultant focus **F** is found by considering the ray which starts from a and passes through o towards f, and remembering that, as it passes through the second lens, it will be shifted forward through the distance between the planes $h'_1\ h'_2$, and turned as though it came from y. A little consideration will show that if the two lenses were close together the width H$_1$ H$_2$ will be the sum of the widths $h_1\ h_2$ and $h'_1\ h'_2$; whilst if the two lenses are moved wider apart H$_1$ and H$_2$ will come nearer together, and may even cross past one another. If the lenses are placed at a distance apart equal to the sum of their focal lengths, H$_1$ and H$_2$ will not only have crossed planes, but will have separated to an infinite distance apart.

The formulæ for calculating the resultant focal length and resultant width between the principal points for a combination of two lenses at a distance apart, are as follows:—

$$\textit{resultant}\ f = \frac{f_1 f_2}{f_1 + f_2 - a};$$

$$\textit{resultant}\ w = w_1 + w_2 - \frac{a^2}{f_1 + f_2 - a};$$

where a is the distance between the lenses, f_1 and f_2 their focal lengths, w_1 and w_2 the widths between their principal points.

From these formulæ it follows that the resultant focal length of a combination of two positive lenses when separated by an interval is always greater than the reciprocal of the

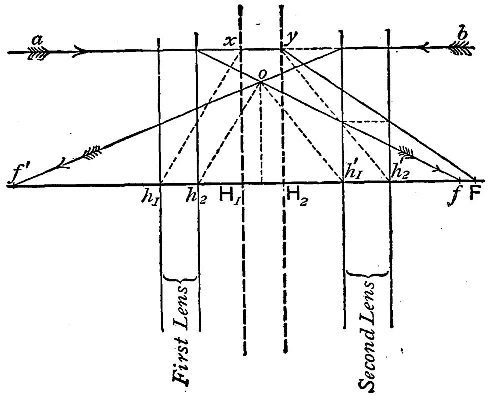

FIG. 5.

sum of their reciprocals, and increases as the lenses are separated. The resultant width between the principal points decreases from the value $w_1 + w_2$ down to nothing, and then increases negatively, becoming infinite when $a = f_1 + f_2$, and again becoming positive and finite when a exceeds that value.

If the optical combination is not achromatic, then the positions both of principal planes and of principal foci will be, in general, different for lights of different colours.

There exists yet another pair of points and planes, having special properties that should be noted. These are the points situated on the axis beyond the principal foci at distances respectively equal to the true focal length on either side. They are marked 1 and S$_2$ in Fig 6, being conjugate and symmetrically

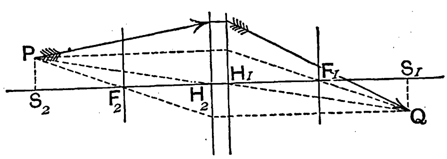

FIG. 6.

situated. Toepler, who first called attention to these two points, called them by the not very apt name of negative principal points (negative Hauptpunkte). I call them the two *symmetric* points, and the planes through them the *symmetric* planes. They possess the very useful properties that any object in one has an image of equal size, inverted, in the other, and that any ray which crosses one of them at any distance from the axis will, after traversing the lens, cross the other symmetric plane at an exactly equal distance from the axis, but on the other side of the latter.

I have now cleared the way for discussing the methods that have been hitherto used or suggested for measuring the focal properties of lenses. Unfortunately, most of the ordinary methods of focometry which are in accepted use are based on the assumption that the lens may be treated as of negligible thickness, and in some others one has to make assumptions beforehand as to the probable width between the principal planes. This is easy enough in the case of a single lens, but for compound lenses the principal planes come in most unexpected positions, at an unknown width apart. After I have enumerated the methods of focometry, and briefly described each, I will describe a new method, and an instrument for carrying it out.

METHODS OF FOCOMETRY.

The methods of focometry may be classified under six general heads; and under these may be grouped the several varieties adopted by different authorities.

I.—METHODS OF DIRECT FOCAL SEARCH.

(*a.*) *Objective Methods.*—The classic simple method of ascertaining the principal focus of a lens or optical combination, applicable only to positive lenses; consisting in sending rays from any very distant object through the lens, and searching for the real image which is received upon a suitable surface, preferably that of a semi-transparent screen.

(*b.*) *Berger's* Method.*—A variety of the preceding, in which an illuminated object and a collimating telescope at a finite distance are substituted for an indefinitely distant object, and the real image at the principal focus is sought by means of an observing microscope.

(*c.*) *Maskelyne's*† *Method.*—A telescope, fitted with crosswire eyepiece, is focussed upon an object at indefinite distance. The (positive) lens under examination being then clamped over the object-glass, it is pointed to a near object, which is moved to such a position as will give an accurate image in the telescope, the position of the object being that of the principal focus of the lens.

(*d.*) *Merz's*‡ *Method.*—A variety of the preceding, adapted to negative lenses. The telescope, with the lens under examination fitted in front of the object-glass, is focussed upon an object at an indefinite distance, and then the lens being removed, is pointed to a near object which is moved to a position giving accurate focus.

(*e.*) *Kerber's* Method.*—The positive lens being placed in front of an illuminated slit, it is moved to such a position that a slab of glass with parallel faces introduced into the path of the emerged rays produces, on being tilted, no change in the apparent position of the slit as viewed in a telescope; this being a test of parallelism of the rays.

None of the foregoing methods are applicable to very short focus lenses, and they give no information as to the Gauss points.

(*f.*) *Pendlebury's*† *Method.*—The positions of each of the two principal foci are found objectively, and then the respective distances are found from these to two conjugate points by inserting a luminous object and finding, objectively, its image. Then calling these two distances p and q, the true focal length is found by Newton's rule as a geometrical mean between them. After this calculation has been made, the distance between the two principal points can be found by subtracting twice the true focal length from the distance between the two principal foci.

II.—METHODS OF MAGNIFICATION.

(*g.*) *Ramsden's Method.*—Measurement is made of the size and distance of the real image formed at the conjugate focus of an object of known size, at known distance: and from these the focal depth is calculated. This method assumes the lens to be of negligible thickness.

(*h.*) *Meyerstein's* ‡ *Method.*—This is a modification of Ramsden's method to meet the case of thick lenses. The lens is placed between an object and a screen fixed at more than four times the focal length apart. Measurement is made of the size of object and image, together with their distance apart, and the distance of the lens from one of them. The lens is then reversed end for end, and is displaced longitudinally until the same magnification is obtained as before on the same

* BERGER.—Apparat zur genauer Bestimmung der Brennweite von Objectivgläsern. "Zeitschrift für Instrumentenkunde," vi. 1886, p. 272.

† After considerable search, I am unable to find any writing of Maskelyne's which describes the method which goes by his name. The same remark applies to Ramsden's method.

‡ MERZ.—Ueber einen neuen Apparat zum Messen der Brenweite. *Pogg. Ann.* 1845, lxiv, 321.

* KERBER.—Verfahren zur Bestimmung der Brennweite von Linsen. *Zeitschrift für Instrumentenkunde I.* 1881. p. 67.

† PENDLEBURY.—"Lenses and System of Lenses" (London, 1884), p. 82.

‡ MEYERSTEIN.—Apparat zur Bestimmung der Brennweite sphärischer Linsen und Linsensysteme. *Wied. Annalen* i., 1877, p. 315; and *Carl's Repertorium*, xiv., 1877, p. 363.

screen. All assumptions about the Gauss points are thus eliminated, for it is clear that if in the second observation, after reversing the lens, the same magnification is obtained as in the first, the second principal point now occupies the position which the first principal point previously occupied, and *vice-versâ*. From the magnification, the distance between object and image, and the measurements of the displacement of the lens, the true focal length is calculated. Dr. Meyerstein describes a special instrument for carrying out this method. This method was devised in 1844, but not published until 1877, after the same principle had been independently discovered and described by Dr. Hoppe.*

(*i.*) *Hansen's*† *Method.*—An object of given size being chosen, the positions of the lens are found which give (real) images of linear magnitudes respectively equal to that of the object multiplied by 1, 2, 3, &c; and from two (or more) of such observations, each of which requires a series of double adjustings, the focal length and the distance between the principal points are calculated.

(*j.*) *Mergier's*‡ *Method.*—This is an elegant mode of carrying out one of Hansen's suggestions. The two symmetric points are found by trial and double adjustment, as in Silbermann's method mentioned below, the magnification here being unity. Two micrometers serve as respecting object and as receptive surface for the image. This adjustment being made, then, in order to produce an image in the same place as previously but of double magnitude, it is sufficient to displace the lens through a distance equal to the focal length, and the object though exactly half this distance. This is accomplished by simple mechanical means, with two screws connected by wheel-gearing.

III.—Methods of Unit Magnification.

These methods constitute a special case of II., but are quite distinctive.

(*k.*) *Silbermann's*§ *Method.*—In this method the lens (positive) is placed at the middle of a graduated bench, upon which two transparent micrometers are placed on either side, so that the image of one micrometer falls upon the other. By a well-known theorem, the total distance between object and image will be a minimum, when the distance between them is equal to four times the focal length, and each is situated at one of the symmetric points of the lens. The operation of finding these symmetric points consists, then, in a series of double adjustments of the following kind:—One of the micrometers being placed at a distance judged approximately as twice the focal length, the second micrometer is then moved, until upon its surface an exact image of the first is formed. If, on comparing the size of the divisions of this image with those of the surface on which it falls, it is found that they do not coincide, but are either magnified or minified, the distance of the first micrometer is either increased or diminished, and the second micrometer is again adjusted to the new position of the image, and a fresh comparison made. By successive trials and approximations the symmetric points are approached; and, when so found, the distance between them is measured, and one-fourth of it taken as the focal length. The method is open to the objections (1) that it is inapplicable to thick lenses, as it does not take into account the distance between the Gauss points, and (2) that it requires a tiresome series of double adjustments. The simple modification of this method, suggested by Webb,* needs no notice here.

(*l.*) *Donders'*† *Method.*—Donders improved the method of unit magnification by substituting for the series of double adjustments a simpler mode of equalizing the size of object and image. He used as object an opaque screen provided with perforations, the linear dimensions of which from one to another were measured with a Helmholtz's ophthalmometer. The lens to be measured being placed in front of this object, an image is then formed on a translucent screen, and the lens is then moved to increasing distances until the size of the image, as measured by the ophthalmometer, is equal to that of the object.

(*m.*) *Snellen's*‡ *Method.*—This method,

* Hoppe.—Ueber die Bestimmung der Haupt-und Brennpunkte eines Linsensystems. *Pogg. Annalen*, clx., 1876, p. 169.

† Hansen.—Untersuchung des Weges eines Lichtstrahls durch eine beliebige Anzahl von brechenden sphärischen Oberflächen. *K. sächs Gesellsch für Wissenschaften*, xv., 1871.

‡ Mergier.—Nouveau focomètre pour la determination des constantes optiques des systèmes dioptriques en général. *Séances de la Société de Physique*. 1887, p. 193.

§ Silbermann.—*Comptes Rendus*, xiv. 1830, Feb. 22, p. 340. See also Verdet, *Cours de Physique*, wherein it states that this instrument was referred to a Commission, consisting of MM. Arago, Babinet, Biot, and Pouillet. No reference to any report of this Commission can be found.

* Webb.—*Literary Gazette*, 1857, p. 1101; and *Fortschritte d. Physik*, xiii. 1857, p. 276.

† Donders.—Bepaling van den Brandspunt-afstand van Lensen. *Versl. en Mededeel* xv., 1863, p. 402.

‡ Snellen.—De Phakometer, ter repaling van focus en centrum van lenzen. *Maandblad voor Natuurwetenschappen*, vii. 1876, p. 23.

which closely resembles that of Donders, is carried out by the aid of an instrument called a *Phakometer*, consisting of a graduated bench at the middle of which the lens is placed. No ophthalmometer is used to measure the sizes of object and image, a translucent screen figured with marks serving to detect any want of equality between the sizes of image and object. It is assumed that the lens has a single optical centre at its centre of figure, and a mechanical adjustment serves to move the object and the screen at equal rates from the lens at the centre. The scale is divided to read off direct in *dioptries* the focal power of the lens. Snellen applies the method to negative lenses and long-focus positive lenses by placing them between two positive lenses of equal and known focal power; and in the case of plano-convex and meniscus lenses, he recommends that to secure symmetry, such lenses should be taken in pairs, back to back, and measured together.

IV.—Methods of Approximate Unit Magnification.

(*n.*) *Bessel's* Method.*—In this method the object and the apparatus to receive the image are placed at a distance from one another, exceeding four times the focal length, and the (positive) lens is placed between them. Two such positions of the lens can be found for either of which the distance between the two conjugate foci is the same. Bessel gives a formula for deducing the focal length from the measurements of the various distances. The method assumes the distance between the Gauss points to be known beforehand, and therefore fails to give any information on the more difficult point to be determined. The advantages of the method are that no measurements have to be made from the curved faces of the lenses, and that none have to be made of the sizes of optical images.

(*o.*) *Oudemans'*† *Method* is simply the method of Bessel carried out by means of a special apparatus, consisting of a simple graduated bench, and hair micrometers. Oudemans gives approximate formulæ for calculating the distance between the Gauss points, for insertion in Bessel's formulæ, but confesses that this procedure fails in the case of many lens-combinations.

* Bessel.—*Astronomische Untersuchungen*, vol. i. p. 137.

† Oudemans.—Sur la détermination des distances focales des lentilles à court foyer. *Archives Néerlandaises*, t. xiii. 1877, p. 149.

(*p.*) *Hasselberg's* Method.*—In applying Bessel's plan, Hasselberg employs as objects the real images of spectrum lines as formed in the focal plane of the eyepiece of a spectroscope. He compares to some hundredths of a millimetre, the performance of a Zeiss's objective constructed of ordinary glass, but assumes the Gauss points by approximate calculation.

(*q.*) *MacGillavry's*† *Method.*—This elegant method departs from Bessel's in that it requires measurements to be made of the respective sizes of object and image, as well as of the distance between them, and of the displacement of the lens between the two intermediate positions of adjustment to exact focus. But by this means all assumptions or estimates about the distance between the Gauss points are avoided. MacGillavry gives three formulæ from each of which this unknown quantity has disappeared by elimination; the true focal length being given in terms of the quantities directly measured, namely, from the relative sizes of object and image in the two positions, and the change in any one of the three measured lengths. Apart from the experimental difficulty of accurately measuring the magnification, MacGillavry's method appears to be very satisfactory.

V.—Method of Approximate Interior Unit Magnification.

(*r.*) *Cornu's*‡ *Method.*—This is one of a group of possible methods in which the respective distances from their related principal foci of two conjugated points are measured, and the true focal length (which is their geometrical mean) is calculated from them; the peculiarity of Cornu's plan being that the two conjugate points employed are close to the two Gauss points, one of them being always interior to the lens. The lens is temporarily marked with ink-lines upon its faces, and the experimental process consists in observing by a reading microscope of sufficiently long focus the positions in space of the principal focus of the lens, the marks on the nearer face, and the internal vertical image of the marks on the further face. From the distances thus measured, together with a measurement of the

* B. Hasselberg.—*Bull. de l'Académie des Sciences de St. Pétersbourg*, xxxii., 1888, p. 412; and *Beiblätter*, xii., 1888, p. 782.

† MacGillavry.—De bepaling der focaal-afstanden van samengestelde optische stelsels. *Mandblad voor Natuurwetenschappen*, v., 1875, p. 73.

‡ Cornu.—Détermination expérimentale des élements principaux d'un système optique. *Journal de Physique*, I[re] Série, VI., 1877, p. 276.

thickness of the lens, the true focal length, as well as the distance between the Gauss points, can then be calculated. In practice, the direct measurement of the thickness of the lens is avoided by the device of reversing the position of the lens and repeating the three readings from the reversed faces. M. Cornu describes an apparatus constructed for him by Duboscq for carrying out these measurements.

(*s.*) *Mebius'* Method.*—This is a modification of the method of Cornu for the particular case of negative lenses, and needs no extended notice here.

VI.—Method of Obliquity of Rays.

(*t.*) *Moser's† Method.*—This method is based on the principle that any ray which on entrance passes through the first Gauss point at any given obliquity with respect to the principle axis emerges with unchanged obliquity, but displaced, as if it had passed through the second Gauss point. To determine these points the experimental process consists in a series of approximations derived from measurement made of the magnification.

Of the various methods thus briefly reviewed, only those of Pendlebury, Meyerstein, MacGillavry, and Cornu fulfil the conditions of determining the values of both f and κ without double adjustments. Doubtless, each has its advantages for particular cases. Yet it appeared worth while to follow out another method which seemed to possess some advantages over any yet suggested.

A New Focometric Method.

In the new method of focometry which the author has devised, direct methods of measurement of lengths only are used; and double adjustments are avoided. The method consists in the direct determination, *firstly*, of the two principal foci by placing a transparent micrometric screen at each; and, *secondly*, when these have been found, the two symmetric points by moving the two screens by a double screw motion through equal distances until each is the image of the other. The true focal length (f) and the distance (κ) between the Gauss points are therefore given by simple subtraction of scale readings.

Choice of the Symmetric Points.

It is easy to show that in any determination of focal lengths, the most favourable position for an experimental measure of any two conjugate points is when these occupy the symmetric points; provided the experimental determination of the two conjugated foci, is *assumed* to be of equal difficulty.

Let p and $-q$ be the respective distances of the point-object and point-image from the two corresponding principal foci. Then by Newton's rule, we shall have

$$f^2 = pq\,; \quad .. \quad .. \quad .. \quad .. \quad .. \quad (1)$$

where f is the true principal focal length.

If in the determination of the lengths p and q we make errors of measurement, respectively Δp and Δq, there will result an error of Δf in the calculation of the focal length, having a value determined by the equation—

$$(f+\Delta f)^2 = (p+\Delta p)\,(q+\Delta q), \quad .. \quad (2)$$

Or—

$$f^2 + 2f\Delta f + \Delta^2 f = pq + p\Delta q + q\Delta p + \Delta p\Delta q \quad .. \quad .. \quad .. \quad .. \quad (3)$$

Subtracting (1) from (3) and neglecting small quantities of the second order, we have:—

$$2f\Delta f = p\Delta q + q\Delta p \quad .. \quad .. \quad .. \quad .. \quad (4)$$

Hence, divided by $f^2 = q$ we get:—

$$\frac{\Delta f}{f} = \frac{1}{2}\frac{\Delta q}{q} + \frac{\Delta p}{p} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (5)$$

or the per-centage error in f is the mean of the per-centage errors in p and q. Hence, since Δp and Δq are obviously of the same order of magnitude, if we write Δm for the arithmetical mean of them, and assume that each of them is equal to this value, we get from (4)—

$$\Delta f = \frac{1}{2}\,\frac{p+q}{f}\,\Delta m \quad ... \quad ... \quad ... \quad (6)$$

which shows that for a given mean error Δm and a given focal length, the error made in determining this focal length will be proportional to $p + q$. Hence those values of p and q which make $p + q$ a minimum will make the error Δf a minimum. And, as $pq = f^2$ is a constant for a given lens, it is obvious that the case of minimum value of $p + q$ is when $p = q$; this being the case when the conjugate points are at the symmetric points.

The assumption made above that the experimental difficulty of determining the position of a conjugate focus is equal for conjugate foci in any position, is, however, hardly justified in practice, for in all laboratory experience it is admitted that it is more difficult to ascertain with precision the position of an image (real)

* Mebius.—Détermination expérimentale des éléments principaux d'une lentille divergente. *Journal de Physique*, 2me Série, ix., p. 511.

† Moser.—Methode die Brennweite und optischen Hauptpunkte von Linsen zu bestimmen. *Pogg. Annalen*, lxiii., 1884, p. 39.

which is remote from a lens than that of one near the lens. In fact, the experimental location of the image is mainly delimited by the sharpness of the crossing of the rays, and the tangent of the angle at which the extreme rays cross is inversely proportional to the distance from the lens. The aperture of the lens then limits the accuracy of determination of foci at great distances. The larger the aperture the more accurately (assuming spherical aberration above) will be the delimitation of the foci; but the larger the aperture, the greater do spherical aberrations become. The error in determining q may arise at either end of the measurement; it is more likely to occur at the end most distant from the lens than at the principal focus. If it be assumed that the probable magnitude of an error Δq made in estimating the value of q is proportional to the distance of this focus from the lens, then we may write Δq as proportional to $q + f$, and similarly Δp as proportional to $p + f$. Substituting these values in (4) we get:—

$$2f\Delta f \propto p(q+f) + q(p+f)$$

and, dividing by f and collecting, we get

$$\Delta f \propto f + \tfrac{1}{2}(p+q).$$

This is still a minimum (for positive values of p and q) when $p = q$, or when the conjugate foci are taken at the symmetric points.

Principle of Focometer for Determining the Focal Planes and Principal Planes of any given (Positive) Optical Combination, such as a Microscope Objective, or other Lens.

The abstract principle of this focometer was described as follows by the author two years ago, in a memorandum accompanying an application made to the Royal Society for a grant in aid of the construction of the apparatus:—

"Let A B (Fig. 7) be the objective (or

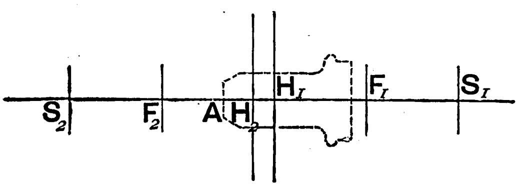

Fig. 7.

lens); H_1 H_2 its principal points: F_1 F_2 its principal foci; and S_1 S_2 the two symmetric points situated each at double the focal distance from the respective principal points S_1 S_2 are conjugate points, and the planes through them are planes of unit magnification.

"Suppose a parallel beam to be sent (from a lamp provided with a reticle in front of it and a collimating lens, all placed in air at some convenient distance away) through A B from left to right. An image will be formed at F_1, thus determining that point. Then, with the same source removed to a distant point on the right, send a parallel beam from right to left, thus determining F_2. Small glass plates, having micrometers cut on surfaces (respectively) nearest to H_1 H_2, and each provided with a reading lens behind, should be used to receive these images, and to ascertain their precise position in space. The said micrometers should be mounted on supports sliding along a suitable bench, over the middle of which the objective has been clamped in a special support. The micrometers, or, at least, one of them, should be so arranged that they can be thrown out of the axis laterally when not wanted. They should be provided with verniers to read off their positions on the bench. They should also be furnished with clamps, which, after each has been once set at its principal focus, will permit it to be clamped to a screw below on the bench. The distance from F_1 to F_2 is equal to $2f + x$ (where f is the true focal length and x the unknown distance between the two principal planes).

"Now, let there be a gearing, such as a right and left-handed screw, which will enable the observer to move the two micrometers from F_1 and F_2 at exactly equal rates outwards. When one of them arrives at S_1 the other will at the same moment arrive at S_2, and this will be known by observing through the reading lens attached to one micrometer the inverted image of the other, coincident, but reversed in position (exactly as in Silbermann's old form of Focometer). The equality of object and image in size—known by the fitting of the micrometer scales—will serve to check the correctness of the observation. The distance from S_1 to $S_2 = 4f + k$. Hence $k = 2F_1 F_2 - S_1 S_2$: and $f = F_1 S_2 = F_1 S_2$. By measuring off backwards from F_1 a distance equal to $S_1 F_2$, the point H_2 is arrived at. Similarly H_1 is arrived at, and these points can be marked off on the outside of the tube of the objective."

Description of the Instrument.

In accordance with the foregoing project, the author designed an instrument which he

terms a Focometer. It was constructed by Messrs. Nalder Bros., of Clerkenwell, to whom the author is indebted for many useful suggestions embodied in the apparatus. The construction is shown in the accompanying figures.

The support for the lens or combination of lenses to be examined is fixed at the middle of a bench made of two parallel girders of gun-metal, each 670 millimetres in length, placed vertically above one another, and secured together both at their ends and at the middle. The highest and lowest faces of this double girder are bevelled at 45°, and a scale of millimetres is divided along the front face at the upper edge. This girder frame is shown from the back in Fig. 8 (p. 32), in end view in Fig. 9. The support for the lens can be raised by a dovetail slide worked by a rack, or moved horizontally transversely to the bench by another dovetail slide furnished with a screw motion, as shown in Figs. 8 and 9.

The travelling supports for the micrometers are two solid pieces of brass, which fit over the bevelled edges of the girders and slide without any looseness of motion along the frame. Each bears a vernier to read off its position on the bench, and each is furnished at its upper point, as shown in Fig. 8, with a horizontal slide for fine adjustment, worked by means of a screw of fine pitch; the position of the horizontal slide being read off by means of a vernier against a short scale cut upon the face of the support. Except when the clamps described below are applied, each of these supports is so far free that it can be pushed along the bench by hand, but is fitted to slide so accurately that it cannot be shifted by any chance touch.

Between the parallel girders, running from end to end of the apparatus, is a double screw, the two halves being respectively right and left-handed, each accurately of a pitch of two millimetres. This screw, the function of which is to shift the two supports for the micrometers, is furnished at each end with a large milled head, and with a driving handle. The screw is of steel. It was constructed in two separate parts, which were then united by being securely rivetted into a short cylinder of steel of larger diameter. This cylinder runs through a bearing in the central piece of the frame of the instrument, and is secured in position between two fixed collars of steel, which are seen edgways in Fig. 8. These collars are screwed up sufficiently tightly to prevent any end play. At the two outer ends the screw passes through two bearings in the end supports, which admit of longitudinal play so as to allow for any difference of expansion between the screw and the frame of the instrument.

The manner in which the driving motion is communicated from the screw to the two travelling supports is peculiar. A device was needed which would admit of the travelling supports being independently moved to any positions when not clamped to the screw, and of being clamped in any position to the screw, so as to be driven by it without backlash. These conditions were finally fulfilled in the following manner. Upon each half of the screw is placed a massive gun-metal nut, about 50 millimetres long, and of square section 25 millimetres in the side. The lower face of this nut slides upon the upper face of the lower girder, and this prevents it from turning; it is also prevented from turning by the interposition, between its upper face and the lower face of the upper girder, of a long slotted rectangular flange of brass which constitutes part of a clamping bar. Each nut is bored out with a short cylindrical cavity. Within this are inserted a spiral spring of steel wire, and a second nut which, though capable of longitudinal play, is prevented from turning by the insertion of a key into a key-way. The introduction of this second nut, with a strong spring between it and the main nut, is a mechanical device originally due to Sir William Thomson, P.R.S., for preventing back-lash. The slotted clamping-bars mentioned above are of brass, each 176 millimetres long. Each is, as may be seen from Figs. 8 and 9, of L-shaped section, fitting over, and in front of the square nut. The upper horizontal flange which comes between the top of the nut and the under side of the higher girder is of accurate fit, and is slotted out to receive beneath it the head of a clamping pin. This pin, passing vertically through a projecting lug of the travelling support, enters the threaded shaft of a clamp screw which bears at its top a milled head. When this is turned, the head of the clamping pin is raised and clamps the slotted bar to the lug of the travelling support. The vertically-situated flange of each of the L-shaped clamping bars fits accurately into the space between the upper and lower girders, and it also is slotted to admit through it a clamping pin which projects horizontally from the square nut. A clamping screw with milled head screws on to this pin, and clamps the slotted bar to the square nut. It is shown in Fig. 9

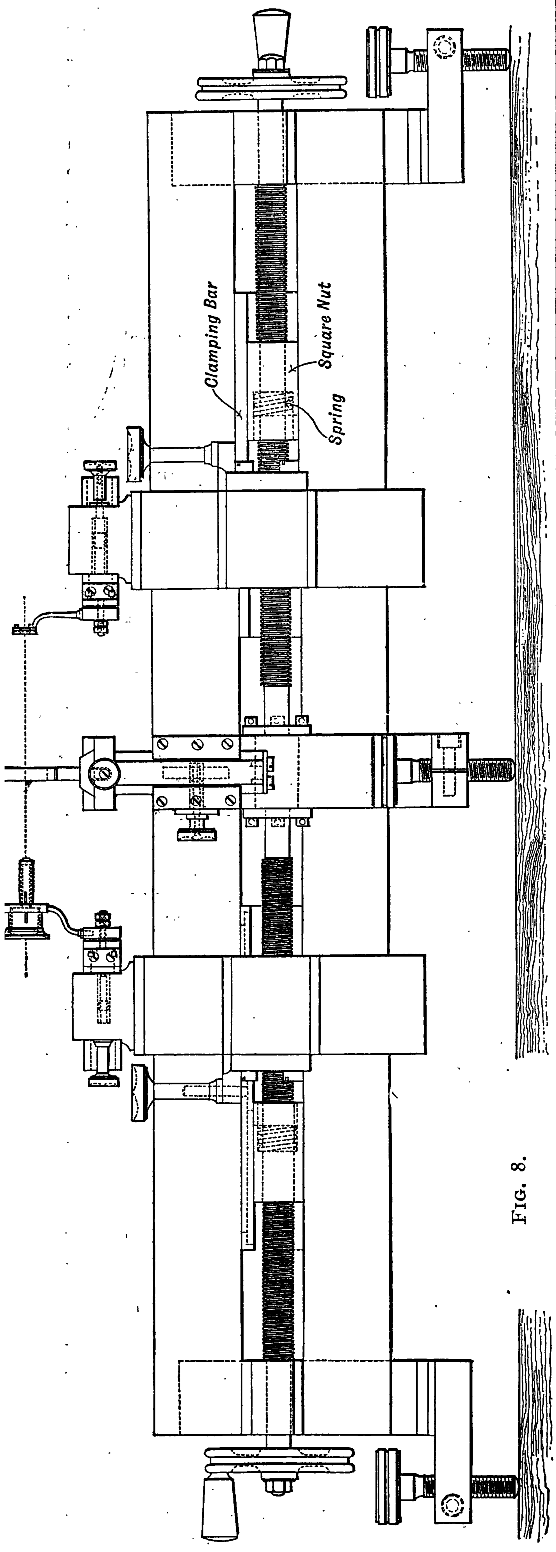

FIG. 8.

projecting to the left. In order that the turning of the long screw may drive the two travelling supports, it is requisite that each should be clamped to its slotted bar, and that each slotted bar should be clamped to the square nut. The object of using such long clamping bars instead of mere short pieces is to enable the travelling supports to be clamped when at unequal distances from the centre of the apparatus, the two square nuts being always situated symmetrically at equal distances from the centre.

The micrometers and other appliances for receiving the focal images are of three different kinds.

The first kind is shown on the left-hand support of Fig. 8. It consists of a small bevel-edged disk of glass, fixed in the

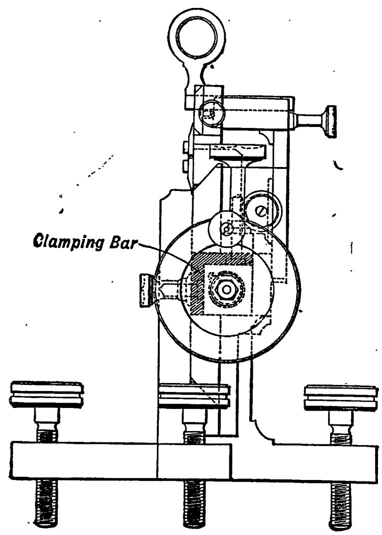

FIG. 9.

end of a narrow tube, and provided with a reading lens or positive eyepiece of about 38 millimetres' focal length. Upon the outer surface of the glass disk is ruled a scale divided into fifths of millimetres. This micrometric arrangement is convenient for receiving a focal image, as formed at the back of a microscopic objective, at a point at some distance down the tube in which the objective is mounted.

The second kind, shown in Fig. 8, on the right-hand support, consists of a rather larger disk of glass, mounted in a metal rim, which is cut away at two places. Upon the front face of this disk, a micrometer scale in fifths of millimetres is also ruled, and one half the disk is silvered over. This

arrangement is convenient for use with larger lenses, and for service as an object, in which case it is illuminated from behind. When making determinations of microscopic objectives it is found convenient to use one micrometer of the second kind opposite the front of the objective, and one of the first kind at the back of the objective; the pieces being mounted as shown in Fig. 8. Each of the micrometers can be shifted laterally out of the line of the lens under measurement, the arm which carries the micrometer being fastened to a collar furnished with a small handle, as shown in Figs. 8 and 9. This collar is guided to move in a plane orthogonally to the optical axis of the apparatus by an adjustment of three abutting screws. These three abutting screws are not shown in Fig. 9, but the heads of two of them are shown in profile in Fig. 8; being situated behind the collar bearing, which receives the curved supporting stem of each of the two micrometers. These bearing-collars are provided with stops to enable the micrometers to be brought up accurately to their former position after having been thrown out laterally.

A third arrangement, not shown in Fig. 8, is used only for large lenses, and consists of a grooved metallic ring mounted on a curved arm upon the top of the travelling support. Over this grooved ring is stretched a piece of thin paper, which, after having a millimetre scale marked upon it, is rendered nearly transparent by the application of varnish. Two such micrometers are used—one at either end—when measurements are to be made upon camera lenses, and other lenses having a focal length of several centimetres.

The holder, fitted upon the central support, as shown in Figs. 8 and 9, for carrying the lens, is cut with the Royal Microscopical Society's standard screw, so as to receive any microscopic objective. For other small lenses an adapter, provided with the same screw, is used, and the lens is temporarily fitted into the adapter by means of a cork ring. For large lenses a **V**-shaped appliance is substituted for the screw holder.

In order to know the position of the lens itself with respect to its focal and principal points, it is necessary to ascertain the scale-reading corresponding to some fixed point on the lens, or on its attached mounting. This might be done by end-measurement, by bringing one of the micrometers up into actual contact with one pole of the lens; but such a mode of proceeding is inadvisable for several reasons. It was therefore decided, when the instrument was being designed, to adopt such a construction as would permit of direct determinations by means of a delicate plumb-line. With this object, the general form of double girder was adopted, so that the scale might be engraved on the front of the vertical face. By reference to the end elevation in Fig. 9, it will be seen that the optical axis of the apparatus is arranged to be in the same vertical plane. Moreover, the micrometers are so arranged that in each case a plumb-line can be hung directly against the actual face of glass or paper upon which the micrometer is engraved. As plumb-line, a thin silk thread with a small leaden sphere at the end of it is used. When the instrument is properly levelled, the plumb-line can be applied to read off directly on the scale the actual position of any of the micrometers; and so by comparison with the readings of the verniers of the travelling supports is obtained the zero reading for use in future measurements.

It was consequently necessary to furnish the instrument with levelling screws. There, however, arose a small mechanical difficulty; for an instrument of this shape would not be very stable if provided with one foot at one end, and two near together at the other. It is therefore provided with four levelling screws, one at each end and two at the two ends of the central support. In practice, this arrangement is quite workable; and it is found convenient first to adjust the level of the girders lengthways by the end screws, then to adjust transversely by the other screws. The frame is so solidly made that there is no fear of racking it by unequal weight upon the four screws; the wooden top of a strong laboratory table is not so rigid as to make any fine adjustment necessary.

Mode of Using the Focometer.

The mode of procedure in using the instrument is as follows:—The lens to be measured having been secured in the central support, it is then adjusted in position so as to be accurately in the axial line between the two micrometers. The clamps of the two travelling supports are left loose, being only applied when required. One of the micrometers (in practice, that shown on the left in Fig. 8) is then thrown out laterally, and a beam of parallel light is thrown through the lens (from left to right, as seen in Fig. 1), so as to form an image at the first principal focus. In practice, this is done as follows:—A com-

pound lens, which is to be used as a collimator, is placed in direct sunlight, and at the focal point, where the image is formed, is placed a piece of ground glass, coarsely ruled with black lines. When this reticle is set in its exact position with respect to the collimating lens, the combination is placed at one end of a long room, about 40 feet long, with a paraffin lamp behind the reticle to illuminate it. The parallel beam thus issuing from the collimating lens is received on the focometer about 20 feet away.

The travelling support on the right (Fig. 8) is then brought up by hand and adjusted so that the micrometer is approximately at the principal focus. It is then clamped to the screw, and, using a positive eyepiece to aid the vision, the micrometer is accurately adjusted to the focus either by turning the main screw, or by the fine-motion screw on the travelling support This first adjustment having been made, the clamps are then unfastened, and the micrometer is thrown out laterally.

A parallel beam is then thrown in a similar fashion in the reverse direction through the lens, and the second micrometer is thrown into line and is brought by a similar process to the second principal focus.

The plumb-line is then applied to ascertain the position of some fixed point of the lens, and to read off the positions of the micrometers, which are replaced in their axial positions: or, if the zero readings of these are known, their positions are ascertained from the readings of their respective verniers.

These three readings having been made, both the travelling supports are clamped to their respective nuts on the main screw. The screw is turned so as to cause the micrometers to travel outwards. The observer, looking into the eyepiece of the micrometer on the left, sees an inverted image of the other micrometer come into view, and, as the screw is turned, the micrometers reach a certain position when both sets of dividing lines are in focus in the same field without any parallax. This position can be very accurately ascertained by shifting the eye slightly from side to side of the lens. The two micrometers now occupy the two symmetric points, and their positions are observed either by plumb-line, or by the readings of their respective verniers.

The simple method of calculating by subtraction of scale readings the true focal length, f, and the distance between the two Gauss points, has been given above.

RESULTS OF MEASUREMENTS MADE WITH THE FOCOMETER.

The following examples are given of measurements made on lenses. In all cases here recorded a red light was used, a ruby glass being interposed.

(1.) *Small Hemispherical Lens*, 12 millims. aperture, by Cooke and Sons.—Front of hemispherical face taken as point of reference, A. Preliminary experiments with plumb-line showed that F_2 is 76·1 millims. behind zero of of vernier Z_2, and F_1 is 49·6 millims. in front of zero vernier Z_1.

Readings of verniers for principal foci are:—

$$Z_1 = 356{\cdot}55 \qquad Z_2 = 199{\cdot}20$$
$$-76{\cdot}10 \qquad +49{\cdot}60$$
$$F_1 = 280{\cdot}45 \qquad F_2 = 248{\cdot}60$$

Readings of verniers for symmetric points are:—

$$Z'_1 = 371{\cdot}52 \qquad Z'_2 = 184{\cdot}17$$
$$-76{\cdot}10 \qquad +49{\cdot}60$$
$$S_1 = 295{\cdot}42 \qquad S_2 = 233{\cdot}77$$

$$f = \text{mean of } F_2 - S_2 \;\&\; S_1 - F_1 = \frac{15{\cdot}03 + 14{\cdot}97}{2}$$

$$f = 15{\cdot}0 \text{ millims.}; \; \mathfrak{F} = 66{\cdot}6 \text{ dioptries.}$$

$$\kappa = 2\,(F_1 - F_2) - (S_1 - S_2)$$
$$= 2{\cdot}05 \text{ millims.}$$

H_2 is at 263·6; H_1 at 265·65 of scale.

A is plumbed at 262·65. Hence first principal point is 0·95 millim. within the front of the hemispherical surface.

(2.) *Substage Condenser* (single lens), by Beck.—Flat upper face of lens taken as point of reference A:—

$$A = 251{\cdot}8$$
$$Z_1 = 356{\cdot}32\,; \quad Z_2 = 196{\cdot}5$$
$$-76{\cdot}1 \qquad +49{\cdot}6$$
$$F_1 = 280{\cdot}22 \qquad F_2 = 246{\cdot}1$$
$$Z'_1 = 370{\cdot}54 \qquad Z'_2 = 182{\cdot}17$$

f = mean of $Z'_1 - Z_1$ and $Z_2 - Z'_2$ = 14·28 millims.

$\mathfrak{F}$ = 65·4 dioptries.

$$H_1 = F_1 - f = 265{\cdot}94$$
$$H_2 = F_2 + f = 260{\cdot}38$$
$$\kappa = H_1 - H_1 = 5{\cdot}56 \text{ millims.}$$

(3.) *Coddington Lens*, reputed one-inch focal length.—Summit of one curved face taken as point of reference:—

$A = 265{\cdot}8$
$B = 280{\cdot}9$
$F_1 = 299{\cdot}3$; $F_2 = 247{\cdot}2$
$S_1 = 325{\cdot}6$ $S_2 = 220{\cdot}8$
$f =$ (mean of $S_1 - F_1$ and $F_2 - S_2$) $= 26{\cdot}35$
$\mathfrak{F} = 37{\cdot}95$ dioptries.
$H_1 = F_1 - f = 272{\cdot}95$
$H_2 = F_2 + f = 273{\cdot}55$
$\kappa = H_1 - H_2 = -0{\cdot}60$ millims.

The Gauss points are crossed, and close together.

(4.) *Objective* 1-*inch*, by R. and J. Beck.

A (front of lens) at 248·2.
$F_1 = 279{\cdot}88$
$F_2 = 241{\cdot}98$
$S_1 = 300{\cdot}09$
$S_2 = 221{\cdot}75$
$f = 20{\cdot}22$ millims.
$\mathfrak{F} = 49{\cdot}46$ dioptries.
$H_1 = 259{\cdot}67$
$H_2 = 262{\cdot}21$
$\kappa = H_1 - H_2 = -\ 2{\cdot}54$ (Gauss points crossed).

(5). *Objective* ¼-*inch*, by R. and J. Beck.—Back focus too deep in tube to use ordinary micrometer; used a 1½ inch objective instead, as auxilliary lens, to explore focus.

A (front of lens) at 252·4
$F_1 = 274{\cdot}88$
$F_2 = 252{\cdot}14$
$S_1 = 281{\cdot}20$
$S_2 = 246{\cdot}2$
$f = 6{\cdot}13$ millims.
$\mathfrak{F} = 163{\cdot}1$ dioptries.
$H_1 = 268{\cdot}75$
$H_2 = 258{\cdot}27$
$\kappa = H_1 - H_2 = 10{\cdot}48$ millims.

(6). *Objective reputed* 16 *mm.*, by Zeiss, ("apochromatic"). (Used auxiliary lens as in preceding for back focus.)

$A = 242$
$F_1 = 258{\cdot}61$
$F_2 = 239{\cdot}2$
$S_1 = 275{\cdot}04$
$S_2 = 222{\cdot}67$
$f = 16{\cdot}43$ millims.
$\mathfrak{F} = 60{\cdot}86$ dioptries.
$H_1 = 242{\cdot}18$
$H_2 = 255{\cdot}63$
$\kappa = -\ 13{\cdot}45$ millims. (Gauss points crossed.)

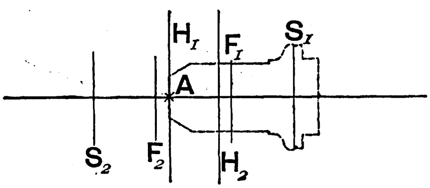

FIG. 10.—ZEISS'S OBJECTIVE.

(7.) *Objective reputed* 8 *mm.* by Reichert.

$A = 251{\cdot}35$
$F_1 = 256{\cdot}72$
$F_2 = 250{\cdot}85$
$S_1 = 263{\cdot}78$
$S_2 = 243{\cdot}79$
$f = 7{\cdot}06$ millims.
$\mathfrak{F} = 141{\cdot}6$ dioptries.
$H_1 = 249{\cdot}66$
$H_2 = 257{\cdot}91$
$\kappa = -\ 8{\cdot}25$ millims. (Gauss points crossed, and lie outside focal planes.)

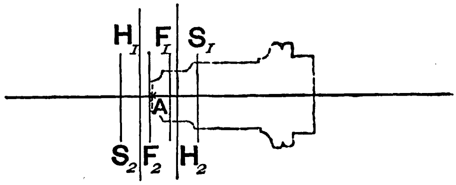

FIG. 11.—REICHERT'S OBJECTIVE.

(8.) *Camera Lens* (landscape), maker unknown.—A. taken at front of mount. All measures plumbed direct.

$A = 233{\cdot}9$
$F_1 = 417{\cdot}8$
$F_2 = 151{\cdot}0$
$S_1 = 547{\cdot}7$
$S_2 = 20\ 45$
$f = 130{\cdot}22$ millims.
$\mathfrak{F} = 7{\cdot}68$ dioptries.
$H_1 = 287{\cdot}58$
$H_2 = 281{\cdot}22$
$\kappa = 6{\cdot}36$ millims.

(9.) *Aplanatic Condenser for Lantern*, constructed by R. and J. Beck on Herschel's formula.—A. taken at front of mount on concave side.

$A = 237{\cdot}5$
$F_1 = 365{\cdot}5$
$F_2 = 193{\cdot}3$
$S_1 = 435{\cdot}7$
$S_2 = 121{\cdot}8$
$f = 71{\cdot}0$ millims.
$\mathfrak{F} = 14{\cdot}8$ dioptries.
$H_1 = 294{\cdot}2$
$H_2 = 264{\cdot}3$
$\kappa = 29{\cdot}9$ millims.

(10.) *Camera Lens* (small landscape), maker unknown.—A taken at rise of mount at front end.

$A = 247{\cdot}2$
$F_1 = 416{\cdot}2$
$F_2 = 136{\cdot}7$
$S_1 = 534{\cdot}2$
$S_2 = -1{\cdot}3$
$f = 138$ millims.
$\mathfrak{F} = 7{\cdot}248$ dioptries.
$H_1 = 278{\cdot}2$
$H_2 = 274{\cdot}7$
$\kappa = 3{\cdot}5$ millims.

No complete examination of any lens for rays of different colours has yet been made, but it

has been found that lens No. 4, examined above for red light, gives with green light a different value for κ, though the lens is sensibly achromatic at the principal focus.

The most interesting results obtained so far are the facts that in so many compound lenses the Gauss points are crossed, the first point being beyond the second. And, in the case of one lens (No. 7), a Reichert's objective, the distance between these two points is found to exceed the distance between the two principal foci. It seems to be a necessity with all wide-angled compound lenses that the aberrations can only be reduced to a minimum by widely separating the constituent lenses, with the result that the optical centres of the combined lens are considerably displaced past one another.

Since the bulk of the foregoing investigations were carried out, the authorities of the Kew Observatory have decided upon undertaking the testing of camera lenses, and issuing certificates of merit. In this work they have had the benefit of the advice of Captain Abney, F.R.S., than whom no one is better able to advise as to what is desired for photographic purposes. This is an excellent beginning, but it is curious that in neither of the certificates issued is any information given as to the position of the optical centres, or their distance apart. The "differences in focal length" for red and violet rays is given, but whether this means difference in true focal length, or difference in position of focal plane, is not stated. What a photographer wants is not agreement in focal length, but in focal plane, which is a very different matter. Also in the "A" certificate issued from Kew, it is proposed to state the optical distortion at 25° from the axis, "including astigmatism." But whether this means that the test is to include one for cylindricity so as to give the direction of the axis of astigmatism in the focal plane, or whether this term is being misused to denote spherical aberration, does not appear. Certainly no really astigmatic lens could be tolerated for an instant in photography, as it would result in all vertical lines being out of focus when all horizontal lines were in focus, or some similar defect.

I notice in a recent most admirable article on photographic lenses, in *Nature*, by Mr. A. Mallock, the term astigmatism is also used for the distance between the primary and secondary foci as produced by oblique rays. But this is not astigmatism at all, and has nothing to do with the cylindricity of the lens, the defect which produces astigmatism. What Mr. Mallock applies this term to is spherical aberration pure and simple.

I pointed out in 1889, in my article in the *Philosophical Magazine*, how the focal power of a lens is the product of a number depending

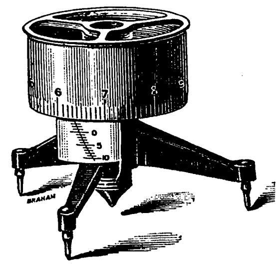

FIG. 12.

only on the properties of the material into the sum of the two curvatures of its faces, or, in the case of thick lenses, of a more complex quantity depending on the thickness of the lens as well as its curvatures. And in order to

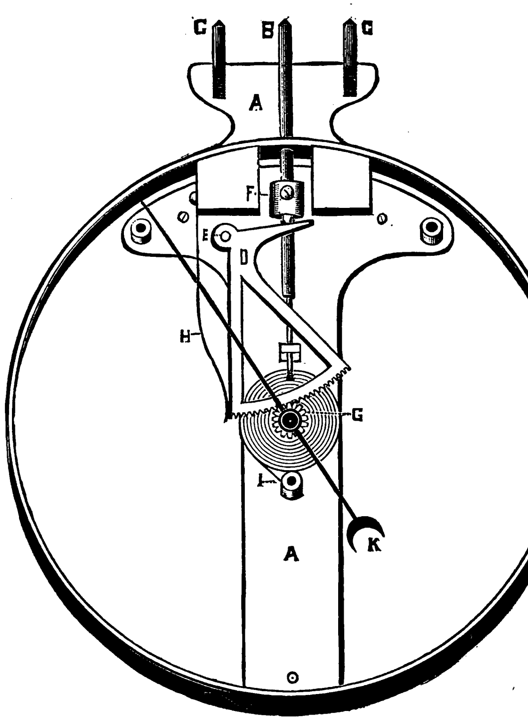

FIG. 13.

facilitate calculations I devised a special form of spherometer—the *dioptrie spherometer*—(Fig. 12) which measures the curvatures of the surfaces directly in dioptries. This was also constructed for me by Messrs. Nalder Bros. To apply this to any simple lens one merely takes

the two readings, adds them, and multiplies by a constant* which depends only on the material. For crown-glass the constant is 0·54; and for flint-glass varies from 0·64 to 0·78 according to density. Since I published this, a still more handy device has been brought out by the Geneva Optical Company, of whom Messrs. Botwright and Grey, of Clerkenwell, are agents in this country. It is known as a "Lens-measure," and is depicted in Fig. 13 (p. 36). It is the invention of Mr. Brayton, and consists of a simple form of spherometer with a multiplying-hand to read off the curvature on a dial. But the latter, instead of reading off the mere curvature of the surface, has the readings of its dimensions already multiplied by the proper constant for crown-glass, namely, 0·54; so that the dioptries of a lens are found simply by adding the reading of the two sides.

I will conclude by expressing my satisfaction that the British Association has seen its way to appoint a committee on the subject of the measurement of lenses. With Professor Carey-Foster as chairman, and with Captain Abney, of South Kensington, and Mr. Whipple, of Kew, as members, such a committee ought to be able to effect some real progress in the spread of scientific methods, and so help forward the industry.

* This is equal $\mu - 1$, where μ is the refractive index; or $(1 - h) \div h$, where h is the velocity-constant (relatively to air).

DISCUSSION.

Mr. G. M. WHIPPLE said he had been much gratified at hearing the reference which had been made to the work done at Kew in regard to lenses, for it ought to be better known that an atttempt had been made in this country to create an optical laboratory. He was also very glad to know that the Technical Institute at Finsbury was doing similar work, and he felt sure that with the appliances they had there and the leisure at their disposal—not of Professor Thompson, but of the senior students—many most interesting questions in optics might be dealt with, and he hoped solved, which could not be accomplished by those who had other duties allotted to them. The measurement of lenses for microscopes had not come within the scope of their operations at Kew; their work was the examination of telescopes for the royal navy, binoculars, gun directors, a class of telescope not much known to the general public which had been recently brought out, besides smaller glasses used in the ordinary work of navigation. Again, the sextants which were employed by cadets must bear a certificate, and this had led to increased accuracy in make. There were also certain minor instruments examined, of which he need only mention one, which required a plane surface. The grinding of a plane glass surface was a somewhat difficult operation, and it had not been much required until recently, when they had been introduced and their use rendered compulsory for cadets as artificial horizons in working their sextants. This was a matter of economy to save the waste of mercury, which was somewhat considerable, when mercurial artificial horizons were employed. Plane surfaces of blackened glass were therefore introduced instead. These things had been going on for some time, but of late the Kew Committee had undertaken the examination of photographic lenses, and he must add to the names of the gentlemen who had been mentioned as laying down the lines on which the work should proceed, that of Major Darwin, formerly director of the photographic department of the School of Military Engineering. He had now retired from the Royal Engineers, and had thrown himself thoroughly into this question of testing photographic lenses. He seemed to have consulted all the authorities he could get at, and had made some very ingenious and beautiful pieces of apparatus for the purpose, amongst them being a modification of Grubb's method of determining the focal length of lenses. It was much larger than Professor Thompson's apparatus, being adapted to test lenses of 6 inch diameter and 30 inch focal length, and was about 5 feet long and the same height. It proved very satisfactory in use. He regretted that the word astigmatism had remained on the prospectus and was kept in use, for it undoubtedly was wrong, but still it was a very convenient term to employ, and he did not know what could be substituted for it, and it was apparently understood by users of photographic lenses. There were other terms as regarded distortion and dispersion, which were not altogether correct, and should give place to a more accurate terminology. The point with regard to focal planes, which formed such an important feature in microscopic work, had not come before them in connection with photographic lenses, nor did they use it at all in testing telescopes and binoculars.

Mr. T. R. DALLMEYER said it was very gratifying to find that at last the efforts which were being made to obtain perfection in optical work were to be subjected to critical and scientific examination, which must result in really good work being appreciated. He was particularly interested in what he understood to be a new theory in treating light, as explained in the early part of the paper, and he wished Professor Thompson had developed it further. One of the main things which opticians had to do was, after calculation, to do what he might describe as grinding a lens on paper, and this work, by ordinary processes, was very labourious. He imagined that if the process of which Professor Thompson had only given the brilliant idea, were carried out with regard to the central pencils, that process of going through the mill in lens grinding would be

greatly facilitated. From the one or two hints which had been given, the method seemed to be simplicity itself. There were one or two other methods of obtaining the nodal points besides those which had been mentioned. He should like to ask if, in particular constructions—one of which he was deeply interested in—one o the nodal points was only radially outside the lens, would such an application be suited to the measurement of the lens as regarded its focus. He understood that, for taking long measurements, such an instrument would be hardly applicable, but that it was chiefly confined to the measurement of lenses where the nodal points were either contained in the instrument, or were very close to it.

Mr. CONRAD BECK said he also had been extremely interested in the paper, because he remembered his fearful struggles in endeavouring to work out lenses on the English system, and the delight with which he hailed the Gauss and the German system of reckoning both the signs and the principal planes. Those who had endeavoured practically to work out lenses on the ordinary system, as given in "Parkinson," and such books, would agree with him as to the enormous difficulties there were, which were entirely got rid of when the proper geometrical method of reckoning the signs, and the complete theory of the Gauss points were brought into work. As Mr. Whipple had said, the chief importance of the nodal points was with reference to microscopic work, and in that case there were some very awkward and difficult considerations. In old days, when the achromatic microscope was first introduced, it was understood that some sort of reasonable magnifying scale should be adopted, and an arbitrary scale was taken, in which the inch meant that it magnified a certain amount with a certain tube length. But nobody knew where the tube length was measured from. An American gentleman the other day published a paper in which he tabulated all the various tube lengths as measured by various English and Continental manufacturers, and they varied most enormously. But, even supposing a definite tube length to be taken, the difficulty still remained, because in order to get a magnifying power which should be in any way consistent with changed eyepieces and object-glasses, it was necessary that low power object-glasses should be mounted in enormously long tubes and high powers in very short tubes. When using a low power you then had to have it a loug way from the object to begin with, and that difficulty was increased by mounting it in a tube 3 inch or 4-inch long, which in the case of a 5-inch would be simply preposterous. Then, again, supposing that for the sake of scientific accuracy, such a plan were adopted,—what could be done in the use of a binocular microscope? With the binocular microscope it was essential to have the object glass as near as possible to the binocular prism, whereas if lenses were mounted on the principle suggested, the low powers, which are the very powers used for binocular work, ought to be mounted a long way away from the tube of the microscope. Until, however, this plan was adopted, no really true method of magnification could possibly be established. As a matter of fact opticians at present were making their low-power lenses very much higher in power than they ought to be in order to obtain this standard magnifying power which was adopted as an arbitrary scale. For instance, a modern 4-inch objective was nothing like 4 inches; it was nearer 3 inches, because its nodal point was too far up the microscope. It was put up to a much higher power to produce the same magnifying power in connection with the same eyepiece. This plan got over the difficulty tolerably, but when you changed the eyepiece you began to find that although with one particular eyepiece the magnifying scale was tolerably constant—and could be made absolutely constant—when you changed the eyepiece it did not affect different powers in the proper ratio, and the scale was thrown out. Mr. Whipple said the nodal points were not of so much importance in photographic and other optical lenses, and he was quite right in saying that their position was not of nearly so much importance, but it was extremely important some means should be adopted which eliminated the distances between the nodal points in measuring the focal length of optical instruments.

Professor THOMPSON, in reply, said Zeiss's way of getting over the difficulty about tube length was not quite as Mr. Beck had stated, because Zeiss distinctly attempted to regulate the depth to which the eyepieces were to be plunged down, so that they should not overlap in the same way as in the old arbitrary scale. Whether he was successful in carrying that out with very low powers he could not say. Mr. Whipple seemed to give no hope that the practical user of lenses would be content to change the misleading term astigmatism; but what were you to do if you came across a lens which had two defects, and both were called astigmatism? If they meant different things you must give a different name to one of them, and he thought you ought to give a different name to the thing which was not astigmatism. Mr. Whipple and the Kew authorities ought to invent a name, and then everyone would be obliged to adopt it.

The CHAIRMAN, in proposing a vote of thanks to Professor Thompson, said that this paper constituted a really important contribution to the knowledge of optical measurements. The instrument which had been shown and explained promised to be very useful indeed in the actual examination and specification of lenses. Hitherto there had been no accurate method which was easily applicable for finding the constant on which the action of any lens, and, still more, a combination of lenses, depended. In the ordinary treatment of the

properties of lenses in this country, even in scientific text-books, one got no further than dealing with lenses which were not infinitely thin, but which were dealt with as though they were, and he hoped the paper would have a great effect in widening the ordinary optical discussions, and bringing the ordinary theory more nearly into accord with actual practical experience. As yet they had hardly got beyond Newton's optics. What Gauss introduced long ago, the idea of the virtual thickness of the lens, had scarcely been recognised in all its importance in this country, though it was of the utmost value in facilitating the statement of the properties of lenses. One small point in the paper which he thought of some importance, was the introduction of a term for what he believed had no name before, which was often referred to in foreign writings as the vertex, and which was here called the pole. Professor Thompson had already made important contributions to optical theory; and he would refer especially to some papers of his which appeared two years ago in the *Philosophical Magazine*, where he showed how very simply the properties of lenses could be expressed by the method he had hinted at in the beginning of this paper—by speaking of the curvature they impressed on the wave front of a beam of light passing through them. In those papers he had treated all the ordinary cases from that point of view with extreme simplicity and beauty, and he hoped this method would be adopted generally in the ordinary treatment of optics.

The vote of thanks was carried unanimously, and the meeting adjourned.

Obituary.

GEORGE WALLIS, F.S.A.—Mr. Wallis, who died recently, was a frequent attendant at the meetings of the Society of Arts when subjects connected with art were discussed. He also read several papers before the Society; in 1856 one on "Recent Progress in Design as applied to Manufactures" (*Journal* iv., 291); in 1859 one on "Embroidery by Machinery" (vii., 318); and in 1863 another on "The New Art of Auto-Typography" (xi., 374). Mr. Wallis was born at Wolverhampton in 1811, and, after leaving the grammar school of that town, he settled for a time in Manchester. As early as 1839 he had devoted his attention to the subject which became his life-work, and he delivered his first lecture on "State Aid for Art" in that year. In 1841 he joined the Government School of Design at Somerset-house, and became, in 1843, Head Master of the Spitalfields School. In December of the latter year he was appointed Master of the Manchester School of Design, an office which he held till 1846. He took an active part in the preparations for the Great Exhibitions of 1851 and 1862, for which undertakings he acted as a Deputy Commissioner. For several years he was Head Master of the Birmingham School of Art, a position he resigned in 1858. In 1863 he was appointed Keeper of the Art Collections of the South Kensington Museum, from which office he retired in July of last year.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 2.—G. H. ROBERTSON, F.C.S., Assoc. Inst. El. Eng., "Secondary Batteries." W. H. PREECE, F.R.S., will preside.

DECEMBER 9.—JAMES DREDGE, "The World's Fair at Chicago, 1893." THE ATTORNEY-GENERAL, M.P., Chairman of Council, will preside.

DECEMBER 16.—GENERAL PITT RIVERS, "Typological Museums, as exemplified by the Pitt Rivers Museum at Oxford."

Papers for which no dates have yet been fixed:—

"Spontaneous Ignition of Coal, and its Prevention." By PROF. VIVIAN B. LEWES.

"Burning Oils for Lighthouses and Lightships." By E. PRICE EDWARDS.

"Dust, and How to Shut it Out." By T. PRIDGIN TEALE.

"Iceland." By T. ANDERSON.

"Artistic Treatment of Jewellery." By I. W. TONKS.

"Agricultural Banks for India." By Sir WILLIAM WEDDERBURN, Bart.

"The Scientific Value of Lovibond's Tintometer." By F. W. EDRIDGE-GREEN, M.D.

"The Agricultural Needs of India." By Dr. J. AUGUSTUS VOELCKER.

"Travels in Indo-China." By LORD LAMINGTON.

"The Woodcuts of Gothic Books." By WILLIAM MORRIS, M.A.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain W. LOVETT CAMERON, R.N.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock:—

January 19, February 16, March 15, April 5, 26, May 24.

INDIAN SECTION.

The meetings of this Section will take place

on the following Thursday afternoons, at Half-past Four o'clock:—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 26, February 23, March 8, 29, April 12, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

A. P. LAURIE, M.A., "The Pigments and Vehicles of the Old Masters." Three Lectures.

LECTURE I.—NOVEMBER 30.—A brief account of fresco painting as described by Cennino Cennini, and of the preparation of panels, gesso work and gilding, in the 15th century. Also a description of the preparation of gilt Spanish leather.

LECTURE II.—DECEMBER 7.—The pigments used in the 15th century, and their preparation and properties, with some account of the methods of painting.

LECTURE III.—DECEMBER 14.—The mediums used by the Old Masters, in tempera and oil painting. The preparation of the oils and varnishes, and the properties of the same.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by PROFESSOR JOHN M. THOMSON, Sec. C.S., on the "Three States of Matter: Solid, Liquid, and Gaseous," on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. P. Laurie, "The Pigments and Vehicles of the Old Masters." (Lecture I.)

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. John Belcher, W. S. Frith, and Thomas Stirling Lee, "Sculpture and Sculptors' Methods in Relation to Architecture."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Sir Robert Ball, "Recent Progress in Astronomy."

Royal, Burlington-house, W., 4 p.m. Annual Meeting.

Microscopical, 20, Hanover-square, W., 8 p.m. Conversazione.

TUESDAY, DEC. 1....Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on paper by Mr. H. K. Bamber, "Portland Cement, its Manufacture, Use and Testing." 2. Mr. A. E. Carey, "The Inspection of Portland Cement for Public Works." 3. Mr. William Smith, "The Influence of Sea-water upon Portland Cement Mortar and Concrete."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "Notes on Transcaspian Reptiles." 2. Miss E. M. Sharp, "Further Descriptions of New Butterflies from British East Africa, collected by Mr. F. J. Jackson during his recent Expedition." (Part II.) 3. Mr. A. D. Michael, "The Association of Gamasids with Ants." 4. Mr. Edward Bartlett, "Notes on the Bornean Rhinoceros."

WEDNESDAY, DEC. 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C. 8 p.m. Mr. G. H. Robertson, "Secondary Batteries."

Entomological, 11, Chandos-street, W. 7 p.m. 1. Mr. George T. Baker, "Notes on *Lycæna* (recte) *Thecla*, *Rhymnus*, *Tengstræmii*, and *Pretiosa*." 2. Mr. Frederic Merrifield, "The Effects of Artificia Temperature on the Colouring of *Vanessa urticæ* and certain other species of Lepidoptera." 3. Mr. W. Bateson, "The Variation in Colour of the Cocoons of *Eriogaster lanestris* and *Saturnia carpini*."

Archælogical Association, 32 Sackville-street, W. 8 p.m.

Obstetrical, 20, Hanover-square, W. 8 p.m.

THURSDAY, DEC. 3 ... Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. West, "A Contribution to the Freshwater Algæ of the West of Ireland." 2. Dr. W. H. W. Strachan, "The Tick Pest in Jamaica."

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Thorpe and Mr. A. E. Tutton, "Phosphorus Oxide." (Part II.) 2. Prof. Thorpe and Dr. A. K. Miller, "Frangulin." (Part II.) 3. Messrs. A. Smithels and H. Tingle, "The Structure and Character of Flames." 4. Miss K. J. Williams, "The Composition of Cooked Vegetables." 5. Mr. T. S. Dymond, "The Occurrences of a Mydicatic Alkaloid in Lettuce." 6. Messrs. S. E. Linder and H. Picton, "Some Metallic Hydrosulphides." 7. Mr. Harold Picton, "The Physical Constitution of some Solutions of Insoluble Sulphides." 8. Messrs. H. Picton and S. E. Lindor, "Solution and Pseudo-solution."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. T. G. Pinches, "The Tower of Babel and Confusion of Tongues."

Archæological Institution, Oxford-mansion, Oxford-street, 4 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Mr. A. R. Dresser, "Toning Bromide Paper and Transparencies."

FRIDAY, DEC. 4...Geologist's Association, University College, W.C., 8 p.m. 1. Mr. Arthur Smith Woodward, "Supplementary Observations on Some Fossil Fishes from the English Lower Oolites." 2. Rev. A. Irving, "Organic Matter as a Geological Agent."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. W. Hibbert, "A Permanent Magnetic Field." 2. Prof. Ayrton, "Note on the Production of Rotatory Currents."

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FRIDAY, DECEMBER 4, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

On Monday evening, 30th ult., Mr. A. P. LAURIE delivered the first lecture of his course on "The Pigments and Vehicles of the Old Masters," in which he illustrated the description of fresco painting by Cennino Cennini, and described the preparation of panels, gesso work and gilding in the 15th century.

The lectures will be printed in the *Journal* during the Christmas recess.

INDIAN SECTION.

A meeting of the Committee of the Section was held on Tuesday, 1st inst., at 4 p.m. Present: Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., in the chair; Lionel Ashburner, C.S.I., Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., M. M. Bhownaggree, C.I.E., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Sir Theodore Cracroft Hope, K.C.S.I., C.I.E., Lieut.-General J. Michael, C.S.I., Alexander Rogers, Thomas H. Thornton, C.S.I., D.C.L., C. L. Tupper, Sir Alexander Wilson, W. Martin Wood, with Sir Henry Trueman Wood, M.A., Secretary of the Society, and S. Digby, Secretary of the Section.

The programme of papers to be read during the present session was discussed.

APPLIED ART SECTION.

A meeting of the Committee of this Section was held on Wednesday, 2nd inst., at 4 p.m. Present:—Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., in the chair; Prof. A. H. Church, Lord Alfred S. Churchill, C. Purdon Clarke, C.I.E., Francis Cobb, Lewis F. Day, C. M. Kennedy, C.B., A. Lazenby Liberty; Vincent J. Robinson, William Simpson, and Hugh Stannus, with Sir Henry Trueman Wood, Secretary of the Society, and H. B. Wheatley, Secretary of the Section.

The programme of papers to be read during the present Session was discussed.

Chicago Exhibition, 1893.

JURIES AND MEDALS.

The report of Director-General Davis upon the subject of awards and juries has been submitted to a sub-committee, and the substance of the report has been agreed to. The report commences thus:—

"With reference to the precedents furnished by the administrative systems of award at the Vienna Exposition in 1873, at the Centennial in 1876, and at the Paris Exposition in 1889, I have to say at the outset that the Centennial Commission made severe radical departures from the regulations that had previously obtained in foreign exhibitions. The most important of these was the awarding of premiums on the recommendation of individual jurors embodied in signed reports, stating the precise qualities of excellence which justified the award.

"The granting of awards on the vote of a majority of the members of a jury, without precise statements of the motives which prompt the decision, has always been unsatisfactory. Its secrecy and irresponsibility incites the exhibitors to use and judges to yield to unfair, or at least improper, influences."

The Director-General says that if the jury of awards is organised by July 1, 1893, its work can be completed substantially by Aug. 16, and the work of revision finished by Sept. 1. In order to do this, he says it will be necessary to employ a large body of clerks by May 1, 1893, to make preliminary preparations for the juries of awards. The number of jurors required he estimates, after consultation with the chiefs of thirteen departments of the Exposition in which exhibits will be entered, is 659, divided as follows:—

Department of Agriculture—Nine juries and sixty-three judges.

Horticulture—Ten juries, fifty judges.

Live Stock—Fifty-three juries, 159 judges.

Fisheries—Five juries, twenty-five judges.

Mines and Mining—Twelve juries, sixty judges.

Machinery—Six juries, thirty-six judges.

Transportation of Exhibits—Four juries, thirty-two judges.

Manufaatures—Thirteen juries, sixty-five judges.

Electricity—Five juries, thirty-five judges.

Fine Arts—Eight juries, forty judges.

Liberal Arts—Nine juries, seventy-one judges.

Ethnology—Three juries, eighteen judges.

Forestry—Three juries, fifteen judges.

Colonel Davis also recommends that a special jury be drawn from the regular group of juries, to give an award to the exhibit showing the best and most satisfactory installation in each of the thirteen departments. It is also recommended that no juries be organised for the classes comprising agriculture, machinery, and musical instruments, as the representative exhibitors in these classes have declared against awarding medals in those divisions of the departments.

Each of the 500 judges outside of the department of live stock are to be paid six dollars a day for their services, which are not to exceed forty days, and the 159 judges in the live stock department to be paid the same rate, their services being limited to ten days. This payment of six dollars per day is made in lieu of expenses, and not as salary.

Colonel Davis believes that 130,000 dollars will be enough to pay the judges. He recommends that artists of the United States be invited to submit models and drawings for the medals, and that 500 dollars be paid for the best design, and 250 dollars each for the two next best designs. The same prizes he recommends should be given for the diplomas. He recommends further that the policy of the Exposition should be very conservative in respect to the number of awards, and that the authorities should study how they will be able to limit rather than enlarge the number. The special prizes and premiums offered by individuals and associations interested in various classes of exhibits, he believes, should be disposed of in some way, and in accordance with the same rules and regulations governing the medals and awards.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 2, 1891; WILLIAM HENRY PREECE, F.R.S., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

De Winton, Major George, Junior United Service Club, S.W., and South Norwood, S.E.
Parker, Thomas, Newbridge, Wolverhampton.
Sandbach, Captain Arthur Edmund, R.E.. A.D.C., care of Messrs. King, King, and Co., Bombay.

The following candidates were balloted for and duly elected members of the Society:—

Adams, Prof. Henry, 60, Queen Victoria-street, E.C.
Allen, James Mason, 11, Gray's-inn-square, W.C.
Allport, William, 36, Southampton-st., Strand, W.C.
Angelo, Elliott, Oriental Club, Hanover-square, W.
Askwith, George Ranken, 119, St. George's-square, S.W.
Barnwell, Richard, Fairfield-works, Govan, near Glasgow.
Basing, Lord, Hoddington-house, Winchfield, Hants.
Beck, William, jun., 3, Glebe-place, Stoke Newington, N.
Bingley, F. S. Norman, M.A., 4, Harrington-gardens, S.W., and Conservative Club, S.W.
Bisset, James, Corsee-house, Banchory, N.B.
Brevetor, Ernest Frederick, Laburnums, Grove-lane, Stamford-hill, N.
Brown, Frederick Gordon, 17, Finsbury-circus, E.C.
Bury, Henry, M.A., 5, Palace Court-mansions, Bayswater, W.
Cane, Arthur, Spring-vale, Bush-hill-park, Enfield.
Cawston, George, Ascot Wood-house, Ascot
Chandler, Frederick L., Lloyd's, Royal Exchange, E.C.
Cheetham, Howard, Carlton-chambers, 18, St. Ann's-street, Manchester.
Child, Gilbert William, M.A., J.P., Cowley-house, Oxford.
Cleeves, Frederick, East-hill, Rotherham, Yorks.
Copland, William Wallace, The Waterworks, Sheerness.
Corthell, E. L., 205, La Salle-street, Chicago, Illinois, U.S.A.
Cruwys, Robert, 465, Brixton-road, S.W.
Cutler, Thomas William, 5, Queen-square, W.C.
Danson, John Towne, Grasmere, Westmoreland.
Dent, Rev. Charles, 76, Westbourne-terrace, W.
Donald, James, 92, Anerley-park, S.E.
Elwes, Henry John, Colesborne, Andoversford, R.S.O., Gloucestershire.
Finnemore, Robert Isaac, J.P., Durban, Natal, South Africa.
Fox, Charles, Roslin, Rectory-road, Beckenham, Kent.
Franklin, Henry Abraham, 14, St. Quintin-avenue, North Kensington, W.
Frost, Robert, B.Sc., 8, King's Bench-walk, E.C., and 42, Duke-street, St. James's, S.W.
Gouraud, Col., Little Menlo, Beulah-hill, S.E.
Graves, Walter, Winchester-house, 50, Old Broad-street, E.C.
Greaves, Joseph Edward Elsworth, Engineering School and School of Science and Art, Rochdale, Lancashire.

Grice, Tom Edmund, Belle-vue, Tonbridge, Kent.
Gripper, George, J.P., Tottenham, Middlesex.
Harris, Walter H., 12, Kensington-gore, S.W.
Hay, John, 11, St. Mary-axe, E.C.
Hill, Frederick Barker, 30, Glengall-road, Peckham, S.E.
Hoblyn, Richard Armstrong, 79, Priory-road, West Hampstead, N.W.
Hogg, Quintin, 5, Cavendish-square, W.
Holt, G. Crompton, Albion-house, Congleton, Cheshire.
Hunter, William, Cathay-house, Eltham, Kent.
Husband, John, Moreton-lodge, Mount Pleasant-lane, Upper Clapton, N.E.
Hutt, Alfred Granger, 8, Oxford-road, Kilburn, N.W.
I'Anson, E. Blakeway, M.A., 7A, Laurence Pountney-hill, E.C.
Irvine, Hugh Alexander, Moray-place, Edinburgh.
James, Alfred, 157, West George-street, Glasgow.
Jones, J. Mortimer, 153, Highbury New-park, N.
Jones, W. Campbell, 32, Bedford-row, W.C.
Kenward, James, 280, Hagley-road, Birmingham.
L'Aker, Major John, Ascot-house, Boscombe, Bournemouth, Hants.
Lamington, Lord, 26, Wilton-crescent, S.W.
Lee, John T., 26, Great James-street, Bedford-row, W.C.
Leeson, Rev. Wilfrid Nevill, B.D., 84, Lancaster-gate, W., and New University Club, S.W.
Low, Alexander G., 38, Pembridge-villas, Bayswater, W.
McCormick, Robert S., 72, Victoria-street, S.W.
McCormick, Rev. W. T., St. Matthew's-vicarage, Brighton.
Macnab, Henry Black, 1, Queen Victoria-street, E.C.
Martin, William, Lambeth Infirmary, Brook-street, S.E.
Meade, General Sir Richard John, K.C.S.I., 65, Queen's-gate, S.W.
Mewburn, George Francis, 10, Elm-park gardens, S.W.
Miles, Colonel Samuel Barrett, The Residency, Oodeypore, Rajputana.
Millson, Alvan, Elmsleigh-house, Paignton, South Devon.
Moore, Alfred, 144, Mile-end-road, E., and Whips Cross, Walthamstow, Essex.
Moore, Commander William Usborne, R.N., 8, Western-parade, Southsea, Hants.
Muir, Thomas, 24, York-terrace, Regent's-park, N.W.
Norris, Walter Henry, Hertford.
Oliverson, Thomas, 2, Hyde-park-gate, South Kensington, S.W.
Phillipps, Richard, 78, Onslow-gardens, S.W.
Phillips, Rev. T. Lloyd, M.A., The Abbey, Beckenham, Kent.
Pilbrow, James, Belpi, Worthing, Sussex.
Piper, Charles Welborne, The Craig, Leyland-road, Lee, S.E.
Rawlinson, Alfred John, Newton-le-Willows, Lancashire.
Reade, Captain Charles Edward, R.N., Rodley-house, Willoughby-road, Hampstead, N.W.
Richardson, Edmund William, 50, Finsbury-square, E.C., and Friern Barnet, Middlesex.
Richmond, William Blake, M.A., A.R.A., Beavor-lodge, Hammersmith, W.
Rickett, William Richard, Sunnyfield, West-heath, Hampstead, N.W.
Riley, William Edward, H.M. Dockyard, Devonport.
Robinson, Prof. William, M.E., University-college, Nottingham.
Ryan, W. P., Ingram-court, Fenchurch-street, E.C., and Warrington-house, Richmond, Surrey.
Sadler, Colonel James Hayes, H.B.M. Consulate, Chicago, U.S.A.
Sandbach, Henry, 129, Mount-street, W.
Sanders, Henry C., Victoria Works, Victoria-gardens, Notting-hill-gate, W., and Elm-lodge, Southall, Middlesex.
Sawyer, Claude Gustav, Junior Constitutional Club, Regent-street, S.W.
Scott, Rev. Robert Selkirk, M.A., D.D., 16, Victoria-crescent, Dowanhill, Glasgow.
Scrutton, Alexander James, 75, Old Broad-street, E.C.
Sedgwick, Frederick Joseph, 72, St. Paul's-road, Burdett-road. E.
Seidler, Charles, 46, Eyot-gardens, Hammersmith, W.
Seton-Karr, Heywood Walter, Atherton-grange, Wimbledon, Surrey.
Smiles, Henry, Tregenna, Parkstone, Dorset.
Spielmann, Marion H., 16, Porchester-terrace, Kensington-gardens, W.
Stephens, Alfred, 3, St. Leonard's-terrace, Chelsea, S.W.
Stephens, Thomas Walls, Downe-house, Richmond, Surrey.
Stone, Edward, 5, Finsbury-circus, E.C.
Thomas, John Blount, J.P., 179, High-street, Southampton.
Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch-end, N.
Verden, Henry, Cowley, Middlesex, and 14, Great Winchester-street, E.C.
Walker, William, Longfield-house, Trowbridge.
Wall, Edward John, 44, High-street, Eccleston-square, S.W.
Warner, William Harding, The Birches, Malvern-link, Worcestershire.
Williams, Henry, Norton-house, 79, Down's-park-road, Clapton, N.E.
Williams, Henry W., Park-house, Brentford, Middlesex.
Williams, Lieut.-Col. Robert, J.P., Bridehead, Dorchester.
Wimshurst, Henry William, 16, Thicket-road, Anerley, S.E.

Worland, Alderman Henry, 55, Barking-road, Canning-town, E.

Young, Prof. Sidney, 13, Aberdeen-terrace, White Ladies'-road, Bristol.

The paper read was—

SECONDARY BATTERIES.

By G. H. Robertson, F.C.S., Assoc. Inst. El. Eng.

Introduction.

The secondary, or, as it should rather be called, the reversible battery, dates practically from the discovery that electric currents could be produced by the agency of chemical actions, and its development progressed with the increase of our knowledge of the laws which govern electrolysis.

In the year 1800, Volta discovered that a current could be obtained through chemical agency, and in the following year Gautherot observed that when electrodes of silver or platinum wire were used for the electrolysis of acidulated water, they gave a current in the reverse direction to that in which the battery current had been passing, if they were connected through a galvanometer directly the battery was removed.

These inverse, or polarisation, currents, as they were called, were a source of great perplexity, aud although much work was done on the subject. and many theories were started to account for their origin by Volta, Ritter, Marianini, Becquerel, Grotthus, and others, no satisfactory explanation was forthcoming until Faraday set the whole theory of electrolysis on a firm basis in his papers communicated to the Royal Society between June, 1833, and March, 1834.

Although many apparent contradictions have been found to Faraday's well-known simple laws, and the precise mode in which a current is conveyed through an electrolyte is still under discussion, yet his work showed that chemical and electrical energy were mutually convertible, and that the so-called polarisation currents were due to the reversible nature of the chemical changes caused by the passage of the primary current.

The way was thus cleared for improvements in batteries in general, and very many have been brought out; but it was not till much later, when Faraday's other great discovery of the laws relating to the conversion of mechanical into electrical energy bore fruit, and provided a cheap source of electricity, that much attention was paid to reversible batteries.

In the course of his experiments on electrolysis, he nearly anticipated Planté's discovery of the peroxide of lead—lead couple, for in the case of the electrolysis of a solution of acetate of lead, he noticed that on the passage of the current, peroxide of lead was formed on the one plate and lead on the other.

In 1843, Grove invented his gas battery; and in 1852, Dr. C. W. Siemens constructed a reversible battery, using carbon plates as his electrodes, and a strong solution of acetate of lead as his electrolyte.

In 1859, Planté made a number of experiments with copper, silver, tin, lead, aluminium, iron, zinc, gold, and platinum voltameters, to determine which was the best couple to use for a reversible battery, and decided on the use of lead plates in dilute sulphuric acid, because in discharge both plates were active, that is, not only did the peroxide of lead plate combine with hydrogen, but the reduced metallic lead combined with oxygen; thus the E.M.F. of the cell was due to chemical actions occurring on both plates. In those days the action of the cell was ascribed solely to the decomposition of water, and the effect of the sulphuric acid was left out of account.

In 1872, Planté improved the "formation" of his cell by bringing out the process for alternate reversals of the current, and in the decade which followed, with the improvement of the dynamo, and the consequent growth of electrical engineering, the need for some means of storing electrical energy arose, and the reversible battery passed from the laboratory into commercial use.

Reversible Batteries.

In 1880, M. Camille Faure invented his cell, in which the electrodes consisted of lead plates, smeared with pastes of red lead and litharge respectively, and covered with a protecting layer of felt. On charging, the red lead was oxidised to peroxide of lead, and the litharge was reduced to metallic lead, thus quickly forming a Planté couple of considerable storage capacity.

The same impetus in electrical work which gave rise to the Faure battery, led also to the introduction of several other types of reversible batteries, and as I have been able to obtain very little information about them, I will deal with them and their developments now, before proceeding with the numerous improvements in the two lead types.

Professors Thomson and Houston have tried electrodes of copper in sulphate of zinc solu-

tion; the plates were laid horizontally, so that the relative weights of the sulphate of zinc and sulphate of copper formed in the working might prevent their mixing too readily. The E.M.F. was the same as that of the Daniel.

M. d'Arsonval modified this battery by making one electrode of lead and the other of zinc, the solution being sulphate of zinc as before. The lead plate forms the positive, and becomes coated with peroxide during charge. According to Miesler, the E.M.F. of this arrangement is 2·13 volt.

Sutton tried copper and lead plates in copper sulphate, the E.M.F. being 1·22 volt.

In 1886, M. Dezmazures brought out a modification of the Lalande and Chaperon cell, the solid copper plate being replaced by a porous one, made by first reducing copper oxide electrically. and then compressing the fine metallic dust so obtained into plates.* The other electrode was made of tinned iron gauze, and the solution was potassium zincate. The E.M.F. is only about 1 volt, but the cells are light, and a battery of this description gave satisfaction, as a source of motive power, at the trials on the French torpedo-boat *La Gymnote*, at Toulon. Recently this battery has been tried for traction work in Philadelphia, under the name of the Waddell-Entz accumulator.† In the American form of the battery, the copper plates are made of a sort of wire rope, formed of a stout wire core, braided over in opposite directions with two layers of wire of different thicknesses, the finest outside. This is again braided with asbestos, or some similar material, which retains and protects the copper oxide formed by electrolysis. The weight of the battery is given as from 55 to 60 lbs. per h.p. stored.

* *The Electrician*, vol. xxii., p. 302.

† *The Electrical Engineer*, No. 23, vol. vii., p. 556.

Lead Reversible Batteries.

On the introduction of the Faure cell into England, in 1881, great hopes were entertained of it, and the modification in the manufacture of the plates seems almost to have been regarded as constituting a fresh type of cell, whereas, since the couple was identical, the chemical reactions were the same as in the Planté cell, and any defect due to these would be common to both. As lead reversible batteries cannot be said to have completely realised the hopes then entertained, it is important to discover whether the non-fulfilment is due to causes which can be remedied by improved processes of manufacture, or whether they arise from the chemical reactions occurring in the working of the cell, and are to be met rather by improved treatment after, than during construction. I have thought, therefore, that a paper containing a summary of some of the principal improvements which have been introduced in the construction of the cells, and an account of some experiments dealing with the chemistry of the subject, might lead to some usefel discussion.

From a comparison of the two cells, made by M. Achard, it appears that on its introduction the internal resistance of the Faure was much higher than that of the former, while the Planté cell took longer to form, and was heavier than the Faure.

The time required for formation, and the weight of the cell, were the chief drawbacks to the Planté process of manufacture; the Faure method had the disadvantage that the applied paste was liable to separate from its support. The remedying of these defects, then, has been the principal aim of the improvements which have been brought out in the two types of the lead reversible battery.* To give a complete list of these would be quite beyond the scope of this paper, but they may be summarised as follows:—

I.—Improvements in the Plante Type.

By the Planté type is meant that in which the peroxide of lead and spongy lead are formed direct from metallic lead by electrolysis.

In this type, since both the weight of the plate and the time required for "formation" can be shortened by making the plate porous, and thus exposing more surface to the action of the acid and charging current, obtaining porosity has been the chief aim of inventors. The methods which have been suggested from time to time may be classified under three headings:—

A. *Chemical.*—The plates are subjected to some "pickling" process, or some special "forming" bath is used.

B. *Mechanical.*—The plates are made of

* For an account of the lead batteries on their first introduction into commercial work, and of the early suggestions to replace them, see a paper by Prof. W. Grylls Adams, F.R.S., read before the Science Society of King's College, 25th October, 1881, and published in *The Chemical News*, vol. xlv., p. 1. In Mr. Niblett's paper on "Some Recent Improvements in Lead Secondary Batteries," read before the Physical Society of Glasgow University last January, and published in *The Electrical Engineer*, vol. vii., Nos. 13 to 17, will be found an account of the principal structural improvements which have since been effected.

granulated lead, wire, or some form of finely divided lead.

C. *Electrolytic.*—(1) The finely divided lead is obtained by the electrolysis of some salt of lead; (2) Some salt of lead is formed into a plate by pressure or otherwise, and then reduced to metallic lead.

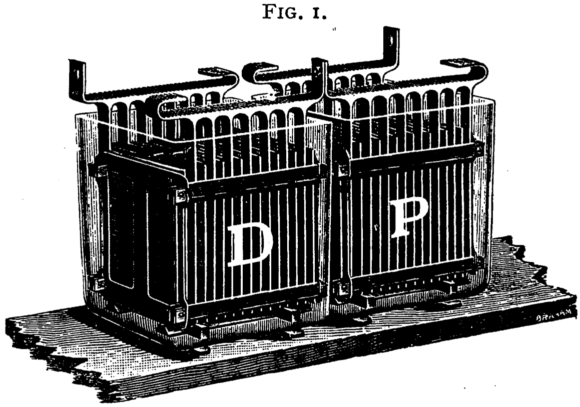
Chemical Processes.—Planté found that plates of lead which had been steeped for a long time in dilute sulphuric acid, before being submitted to the action of the charging current, "formed" more rapidly than those which had not been so treated, and he also found that "formation" was hastened by heating the cell during the process; this, however, was difficult in practice.

In 1882, in order to roughen the surface, he pickled the plates, for from twenty-four to twenty-eight hours, in a bath composed of nitric acid diluted with from once to twice its volume of water. The plates were then thoroughly washed, and the formation completed in a bath of dilute sulphuric acid one to ten. By this improvement he stated that a capacity, which under the old process took several months to obtain, could be acquired in eight days.

Almost simultaneously, Messrs. Elwell and Parker suggested the use of a mixture of nitric and sulphuric acids as a pickling bath. Since then different baths, containing nitric acid in varying proportions, have been brought out, and from the earliest times the addition of some salt of the alkalies, such as ammonium, sodium, potassium, or magnesium, sulphate to the electrolyte during formation, has been suggested as an improvement.

In 1884, Mr. FitzGerald proposed the use of phosphoric acid; and in the same year Mr. Tribe experimented with plates partially or

FIG. 1.



MESSRS. DRAKE AND GORHAM'S CELL.

wholly converted into sulphide, phosphide, or arsenide, prior to "forming" them by electrolysis.

Coming to recent processes, in 1890 Mr. Epstein suggested first boiling the electrodes in a bath containing

1 per cent. nitric acid;
1 „ „ potassium permanganate;

or else, in lieu of the permanganate, two per cent. carbonate or sulphate of sodium, or one per cent. sulphate of manganese. The plates are dried in air, and then "formed" by the action of the current in an electrolyte containing acetic, phosphoric, or tartaric acid, in the proportion of one-half to two per cent.

A few months later, Dr. Paul Schoop brought out his process for first subjecting the plates to the action of a current of about one-sixth of an ampère per 100 sq. c.m., at 50 degees Fahrenheit, in a bath composed either of—

100 parts by weight ammonium sulphate;
140 „ „ „ sulphuric acid (50 degs.);
⅔rds 1 pt. „ „ potassium chlorate:

or else—

100 parts by weight water;
5 „ „ „ sodium bisulphate;
⅔rds 1 pt. „ „ potassium chlorate.

The treatment is continued for from thirty-six to 100 hours, according to the depth of the active material required. The formation is completed in ordinary dilute sulphuric acid.

Mechanical Processes.—Messrs. Crompton and Howell's well known plates, formed by the compression of a specially porous granulated lead, are an instance of this type, and from their great porosity, they are capable of a very high rate of discharge.

In Messrs. Drake and Gorham's cell (Fig. 1), the plates are formed of roughened

strips of lead, laid horizontally one over the other, and connected by their ends to upright rods. From its construction this plate is free to expand and contract without injury to itself.

In Mr. Niblett's so-called "solid cell," * the electrodes are separated by porous partitions, and the space between the electrodes and the partitions is filled up with granulated lead. In this cell there is practically no free electrolyte to wash about and spill; it is all absorbed either in the mass of spongy material forming the electrodes, or in the porous partitions.

Plates have also been made of compressed lead dust, of wire loosely woven and compressed, as in Reynier's cell; or in the form of rope, as in the Legay cell.

M. Bandsept's plates would appear to be of this type, as they are made of extremely finely pulverised material, which is then compressed into briquettes, and subjected to a forming process. The cell is now in use commercially in Brussels, but very little information can be obtained about it.

ELECTROLYTIC PROCESSES.

1. *The electrolysis of some lead salt solution.*—The acetate of lead has been frequently employed for this purpose since Siemens used it; and another salt that has been the subject of many patents is the chloride of lead. In America last year it was proposed by an Englishman, named Currie, to form the electrodes of rods or bars of lead coated with woven asbestos. These electrodes are then placed as anodes in a bath of zinc chloride, and lead chloride to the required depth is formed on them, while zinc is deposited on the cathodes. On reversing the current, spongy metallic lead is produced on what are now the cathodes, and the zinc goes into solution, being thus used over and over again.

2. *The reduction of a plate formed of some salt of lead.*—Perhaps more patents have been taken out under this heading than any other. Plates have been formed of the fused chloride; cerussite, or the native carbonate, has been compressed into plates, and in fact any salt of lead, even lead sulphate, which can be got to reduce to metallic lead by the action of the current, has been employed.

In the Laurent-Cely cell the plates are composed of pastilles of specially prepared lead chloride, round which frames of an alloy of lead and antimony are cast. By the action of zinc in very dilute hydrochloric acid, the plates are converted into cellular lead. The plates are then washed in cold water, dried, and the positives converted into litharge by the action of a current of hot air. The formation is then completed by electrolysis in the usual way.

For this cell it is claimed that the density of the positives is 4·3 to 5, while that of the negatives is only 3 to 3·5. Great storage capacity for weight is also claimed.

* *The Electrical Engineer*, vol. viii., No. 4, p. 80.

II.—IMPROVEMENTS IN THE FAURE TYPE.

By the Faure Type is meant that in which the peroxide of lead and spongy lead are formed by electrolysis from some oxide applied to the plates.

As in this class of cell the active material is applied to the electrodes, and not formed from them as in the original Planté cell, it is obviously desirable that the supporting part of the electrode should be light, and not weakened by taking part in the chemical reactions. These requirements have been met in many instances by replacing the solid lead plate by a grid, usually made of an alloy of lead and antimony, since such an alloy is less acted on by the acid, and is much stronger than pure lead. In the E.P.S. cell the use of an alloy of lead and antimony was abandoned, because, if sufficient antimony to obtain a good casting was added, the grid was so hard that it did not yield to the expansion of the paste, which consequently forced itself out of the plate. Lead grids were then employed, but now they have been abandoned for rapid discharge work, and a solid plate has been reverted to.

In the latest form of Mr. FitzGerald's lithanode cell, weight is reduced by making the support of a light double frame of copper wire, protected from the action of the acid by dipping it first in soldering fluid, and then in molten lead.

The other improvements fall into two principal divisions:—

A. Those which have for their object the retention of the paste on the plate, and they may be classed under four headings.

B. Those intended to provide better connection between the support and the active material.

A.—The Retention of the Paste.—1. The plate is not perforated, but grooves or recesses are made on the surface; or it is cast with projections from it, so as to afford a lodgement for the active material.

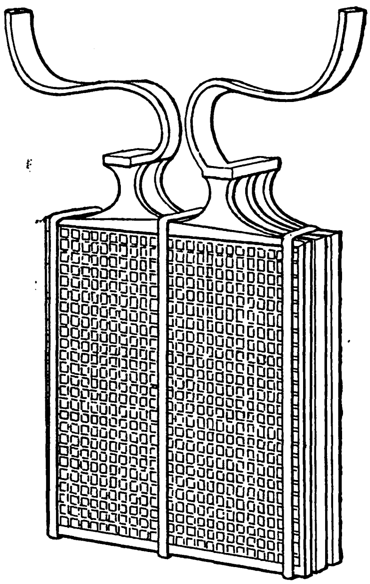
The Tudor plate is a familiar instance of this type, which has the advantage that the support gradually gets "formed," and supplies

active material to replace that lost in the working of the cell.

In the new 1890 pattern E.P.S. plate, an early form, introduced originally by Swan, has been resorted to. The plate is grooved horizontally, as in the Tudor plate, and the ridges between the grooves curve slightly upwards towards the surface of the plate, forming a lodgement for the paste.

2. The support is some form of "grid," that is, is perforated with holes, as in the old pattern E.P.S. plate, and the Julien grid (Fig. 2).

FIG. 2.



ELEMENT CONSOLIDATED EL. STORAGE CO.

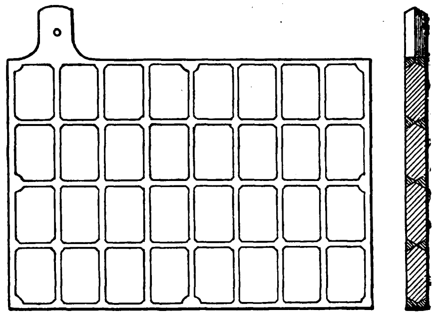
A great many varieties of this form of plate have been suggested, and the apertures have been made by casting the grid in a mould, and by punching. Their form has been cylindrical, barrel shaped as in Messrs. Drake and Gorham's positive plates, shaped like two cones joined at the apexes, and to give greater security the perforation has been made to expand again just at the junction of the apexes.

The construction of a mould, to produce a perforation expanding inwardly, is a matter of difficulty, and therefore the grids are sometimes cast in two halves, and subsequently joined, as in the Gadot cell (Fig. 3). In the Correns cell, (Fig. 4), much used in Germany, the grid takes the form of a double lattice.

3. The active material is enclosed in a perforated conducting retaining vessel.

In this case also the devices resorted to have been very numerous. Plain or corrugated sheets of lead have been taken and folded into boxes, either before or after applying the paste.

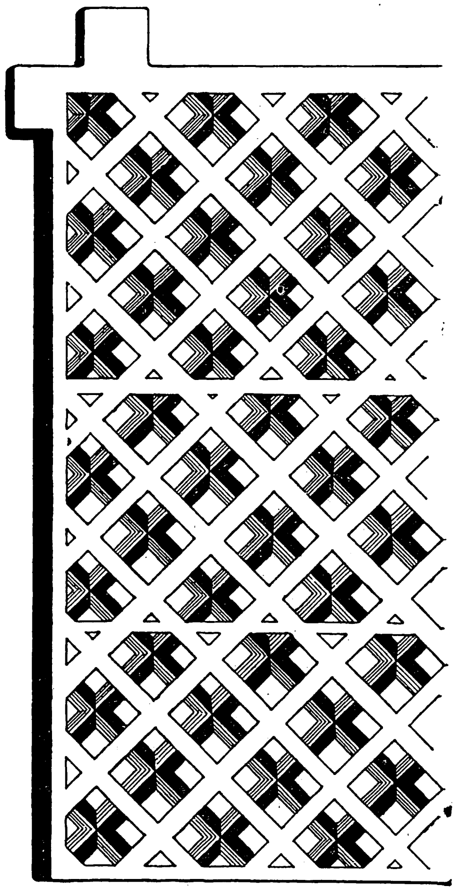
FIG. 3.



PLAN AND SECTION GADOT PLATE.

In the Roberts cell (Fig. 5, p. 49) two grids are taken, pasted on one side, and then united to form a plate with the paste inside (Fig. 6, p. 49).

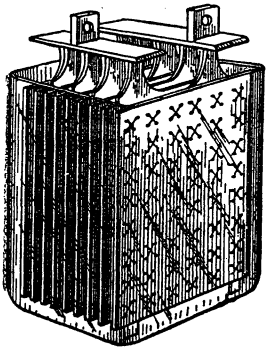
FIG. 4.



PLAN OF CORRENS DOUBLE GRID.

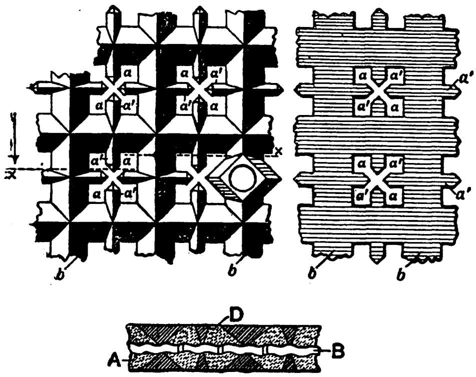
In Dr. Tommassi's multitubular cell (Fig. 7, p. 49) the retaining vessel may be constructed o

Fig. 5.



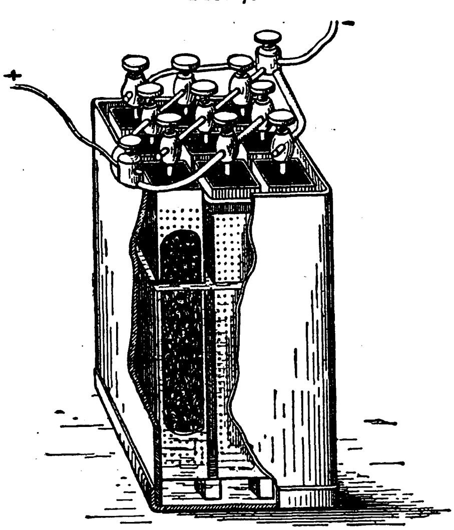
"Roberts" Cell, Complete.

Fig. 6.



"Roberts" Cell: Detail of Plate.

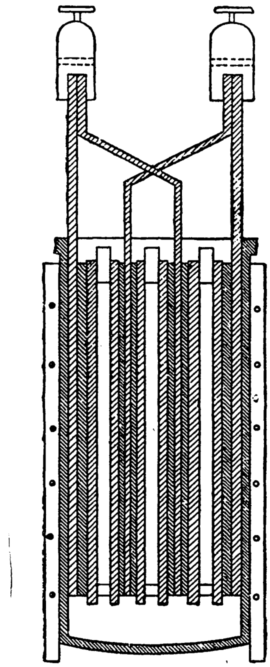
Fig. 7.



Tomassi Cell, Corner Cut away to Show Internal Arrangement.

metal, but is usually of some non-conducting material, and so comes under the next heading.

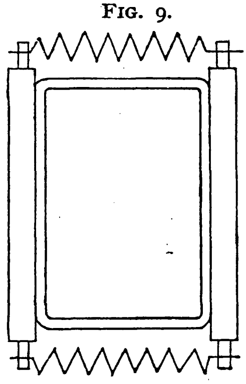
Fig. 8.



Reynier Element: Side View.

4. The enclosing vessel or plates are made of some non-conducting material, or some inactive material is packed between the plates,

Fig. 9.



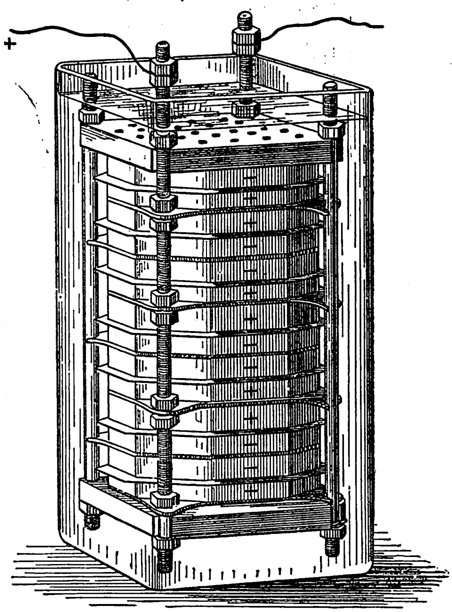
Reynier Element: Plan of Compressing Arrangement.

to prevent short-circuiting, and retain the active material.*

* The improvements under this heading are equally applicable to cells of the Planté type; but as they are more frequently applied to cells of the Faure type, I refer to them under this heading.

In France, the plates have been covered with perforated sheets of celluloid; Reynier brought out what he called an "elastic cell," specially designed for use on torpedo boats. When tried in 1886, on board *La Gymnote*, it was not a success, and the alkaline copper cell was preferred to it. Since then, however, the construction has been much improved (Fig. 8, p. 49). Each cell, according to improvements effected in 1889, is composed of one positive, two negative plates, and four porous partitions held together, as shown by a frame consisting of two end plates connected together by corrugated strips of metal, which have sufficient elasticity to enable them to expand and contract with the alteration in volume of the plates caused by charge and discharge (Fig. 9, p. 49).

FIG. 10.



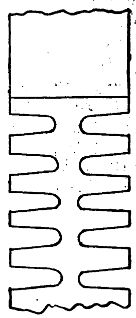
"ATLAS" CELL.

In this country Mr. Barber Starkey has tried filling in between the plates with a mixture of plaster of Paris and sawdust; Mr. Fuller uses porous pots; and in the United States, in the Pumpelly battery, cellulose, or wood pulp, is used to separate the plates, which are arranged horizontally, as in the "Atlas" cell (Fig. 10).

B.—Improved Connection between the Applied Oxide and the Support.—With this object the support has been well rubbed with carbon before applying the paste, and the addition of carbon to the paste in some form has been frequently recommended, as, for instance, kneading the oxides into a paste with lead acetate.

In the Tudor cell (Fig. 11) the positive plates are first treated by Planté's process, to coat them with a layer of crystalline electrolytic

FIG. 11.

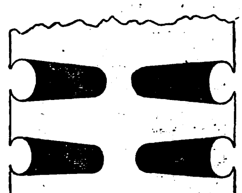


TUDOR PLATE: SIDE VIEW, EMPTY.

peroxide; the grooves are then partially filled with a paste of peroxide of lead, and pressure is applied to the ridges to expand them, and partially close the mouths of the grooves (Fig. 12).

The casting or welding of the applied oxide to the plate has also been tried, and, to overcome the difficulty of getting the substances to blend into one another, caused by the great difference in their melting point, it has been suggested to fill the portion of the mould usually occupied by the support with some reducing agent, such as carbon mixed with nitre, so that when the fused oxides are poured into the mould they will be reduced in part to metallic lead, which will assume the place and shape of the carbon core, while the remainder forms the active material.

FIG. 12.



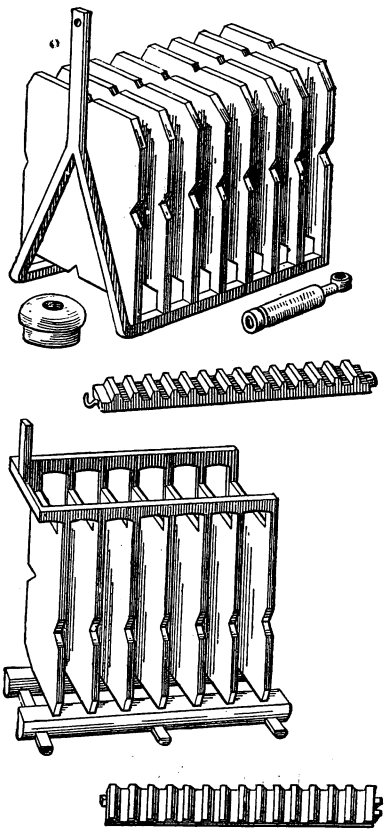
TUDOR PLATE: SIDE VIEW, FULL.

General Improvements.—Besides the improvements in what may be called the manufacture of the plates, or electrodes proper, various devices have been resorted to with the view of diminishing the resistance of the lugs,

and securing better contact between plates of the same sign, such as making connection by tinned copper rods passed through holes in the lugs. Lead is afterwards cast round the copper, so that it is screened from the action of the acid.

Some attention has also been given to the question of the best electrolyte to use, some advocating the use of acid of density 1,150 to 1,180, while others recommend a density 1,200 and over. The addition of small quantities of some salt of the alkalies, such as sodium sulphate or carbonate, has been recommended

FIG. 13.



PLATES OF "OERLIKON" CELL SEPARATED.

by Mr. Barber Starkey and others, with a view of reducing sulphating; and Dr. Paul Schoop has brought out a successful gelatinous electrolyte, by adding one volume of dilute sodium silicate, density 1·180, to two volumes of dilute sulphuric acid, 1·250.

In order to prevent shortcircuiting between the plates by the material dislodged in working, they are now either slung, or rest on supports, which are so placed that the formation of a layer of mud between them is prevented.

The equalisation of the chemical action over the surface of the plates has also been attempted, and in the Schoop cell (Fig. 13) the current enters at the top of one set of plates, and leaves from the bottom of the others. The plates also are widely spaced now as a rule, the proportion of acid to plates has been increased, and little alterations are constantly being made to secure the free circulation of the electrolyte essential to regular working.

THE CHEMISTRY OF THE ACID.

Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell, namely:—The high initial E.M.F. of a freshly-charged cell; the fall of E.M.F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as after a rest a fresh discharge can be obtained.

As the defects, namely, sulphating and buckling, which have retarded the introduction of reversible lead batteries, are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E.M.F.; therefore, as the work of Dr. Oliver Lodge* in 1883, and of Miesler† in 1888, had shown that the causes of the variation must be sought either on the lead plate, or in the acid next it, and the chemistry of the plates afforded no explanation,‡ I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

Planté § had considered that the peculiarities in E.M.F. were due to the formation of peroxides in the acid, and showed that the conditions existing in a cell were favourable to their production, since in voltameters with lead electrodes they were formed in greater quantity than in those with platinum. He also noticed that, immediately on the cessation of the charging current, there was often a small evolution of gas from the peroxide plate; this evolution

* Cantor lecture.

† Monatshafte fur Chemie, viii., 713

‡ For references and a summary of the principal work done on the cell, see *The Electrician*, vol. xxvii., No. 682, p. 165; No. 692, p. 437.

§ Recherches sur l'Electricité.

Accumulator.	Type.	Material of Cell. Lead, plates, and H_2SO_4, or otherwise.	Capacity in Ampere Hours.	Capacity in Watt Hours.	Charging Current.	Max. Discharging Current.	No. of Plates. +	No. of Plates. −	Thickness of Plates in inches. +	Thickness of Plates in inches. −	Total Area of Plates (sq. ft.)	Amperes per sq. ft. Total plate area. Discharge.
REYNIER ...	—	Lead and lead peroxide in sulphuric acid.	30	740	—	6 amperes	—	—	—	—	—	—
E.P.S. ...... (Electric Power Storage Co.)	1888 L	Lead grids pasted. H_2SO_4	130	247	10 to 13	13	3	4	—	—	—	—
	1890 K	Ribbed Lead Plates pasted. H_2SO_4	—	—	15 to 25	25	3	4	—	—	—	—
GERLIKON ..	B	Hard lead grid pastes made of red lead and litharge.	50	95	6	10	4	5	0·2	0·2	1·9	5
	E		260	494	30	48	5	6	0·2	0·2	8·9	5·4
	F		160	304	18	25	5	6	0·2	0·2	5·6	4·4
	D		70	133	9	9	8	9	0·1	0·1	3·8	2·3
"D.P."...... (Drake and Gorham)	A	Pasted positives. Lead negatives dilute H_2SO_4	140	265	12	12	—	—	—	—	—	—
	H		725	1,377	66	66	—	—	—	—	—	—
TOMMASI MULTI-TUBULAR.	—	Red lead and litharge in porus pots. Dilute sulphuric acid.	321	642	25 to 100 amperes.	18 to 30	9 tubes	9 rectangular	9·75-in. by 2-in. by ¾-in.	9¾ by 2 by ¾	—	—
JULIEN ...... (Consolidated Electric Storage Co.)	S. 17	Pasted plates...	180	—	15	20	8	9	1-8th	1-8th	5·4	3·6
		Dilute sulphuric acid	180	—	15	20	8	9	1-8th	1-8th	5·4	3·6
GADOT	1 A	Double grid containing pastelles made from oxides of lead. H_2SO_4	28	53·2	3·1 amperes	52	2	3	—	—	—	—
	10 E		1,063	2,019·7	116	193	11	12	—	—	—	—
CROMPTON-HOWELL.	No. 11	Lead plates and H_2SO_4	220	440	28	85	5	6	¼	¼	11	20 at 3 or 10 at 10
	17		340	680	42	135	8	9	¼	¼	17	
	21		420	840	52	170	10	11	¼	¼	21	
	31		620	1,240	78	250	15	16	¼	¼	31	
	61		1,200	2,400	152	500	30	31	¼	¼	61	
ATLAS. ...... (Société des Applications de l'Electricité)	No. 1	Block composed of plates made of oxides and salts of lead. H_2SO_4.	150	$\left(\frac{2+1\cdot8}{2}\right)150$ 285	8	16 normal 10	10	10	0·4	0·4	—	—
ROBERTS ...	Modified Faure twin plate.	Lead alloy, H_2SO_4 combined with an alkaline solution.	75	162	15	Practically unlimited.	2	3	9-32	9-32	18 9-12	4
			150	325	25		4	5	9-32	9-32	33 9-12	4
			250	545	35		4	5	9-32	9-32	63 9-12	4
			450	990	50		8	9	9-32	9-32	108 9-12	4 (about)
LEGAY	—	Plates made of lead wire rope formed by Plante's process.	194	364	20 amperes	200 amperes	4	5	2-3rd	2-3rd	75	—
TUDOR	VII.—A	Lead	240	456	18	24	—	—	1·3	1·3	—	—
	D	Lead peroxide in dilute sulphuric acid.	168	321	48	60	—	—	1·3	1·3	—	—

Approximate External Dimensions of Cell. Length.	Breadth.	Height.	Height over all.	Total Weight of Cell (lbs.)	Ampere Hours per lb. of Total Weight.	Watt Hours per lb. of Total Weight.	Efficiency (Watt).	By whom Efficiency Test was made.	Remarks.
12-in.	12-in.	—	12-in.	100	0·3	7·4	—	—	These cells are made up in boxes containing 16 couples.
5¼-in.	13¼-in.	18¼-in.	20½-in.	74	1·7	3·3	—	—	—
5½-in.	11½-in.	13½-in.	16½-in.	81	—	—	—	—	—
7·8-in. 9-in. 9·2-in. 5·5-in.	9·2-in. 14·4-in. 11·7-in. 6·8-in.	8·77-in. 16·4-in. 12·5-in. 8·6-in.	— — — —	39·6 156·2 96·8 26·4	1·25 1·6 1·9 2·6	2·4 3·1 3·1 5·0	— — — —	Prof. Kolrausch, Hanovet. Dr. Koppe, Zurich.	— — — —
13½-in.	8-in.	12½-in.	—	65	2·1	4	—	—	—
13½-in.	18-in.	12½-in.	—	240	3	5·7	—	—	—
6¾-in.	6¾-in.	10½-in.	—	Total weight of the electrodes, 47·7 lbs.	Per lb. of electrode, 6·7	—	80 per cent.	—	The weght of the containing vessel is 6·6lbs., and the volume of the acid is ¾ gallon, but as the density is not given, the total weight of the cell cannot be calculated.
8-in.	7-in.	10-in.	—	42 lbs.	4·3	—	—	—	The 180 amp. hours capacity is at a discharge rate of 10 amperes.
7½-in.	5¾-in.	9-in.	—	37½ lbs.	4·8	—	—	—	The electric lighting cells are in glass jars, the traction in covered rubber. Electric lighting and traction.
7-in.	3¾-in.	—	13·6-in.	17·6	1·6	3	—	—	—
21·6-in.	20·4-in.	—	26¾-in.	792	1·4	2·66	—	—	—
8½-in. 13½-in. 16½-in. 29-in. 54½-in.	12½-in. 12½-in. 12½-in. 12½-in. 12½-in.	12-in. 12-in. 12 in. 12-in. 12-in.	14-in. 14-in. 14-in. 14-in. 14-in.	115 182 220 460 880	1·9 1·9 1·9 1·4 1·4	3·8 3·8 3·8 2·8 2·8	85 per cent. Current efficiency 93 to 95 per cent.	Kennedy-Crompton, engineer, of Kensington and Knightsbridge Company.	For electric lighting, traction, and also electric welding.
7-in.	6·29-in.	inch. 12·57	inch. 13·75	Weight of plates = 17·63 lbs.; of acid = 6·6 lbs.; of the containing vessel is from 2·2 to 8·8 lbs.	9·6 per lb. of plates. 5·4 to 7 per lb. of total weight.	16·1 per lb. of plates. 8·6 to 10·9 per lb of total weight.	—	—	—
7½-in. 7½-in. 9½-in. 9½-in.	2½-in. 5-in. 5-in. 10-in.	10-in. 10-in. 12-in. 12-in.	12-in. 12-in. 13½-in. 13½-in.	20 38 70 110	3·75 3·95 3·55 4·09	8·01 8·55 7·71 9·00	87 to 93 per cent. according to rate of discharge.	G. M. S. Wilson, Sec. Acc. Company, Toronto. Wm. Roberts, Elec. Acc. Company, Toronto.	The battery is designed for both electric lighting and traction purposes.
9-in.	9-in.	9-in.	11½-in.	65	3·07	5·6	—	Laboratory of Société Internationale des Electriciers.	Total weight of plates = 44·1 lbs.
—	—	—	—	112·2	2·1	—	—	—	The plates weigh 112·2 lbs. The weight of the glass containing vessel is 26·4 lbs., and the cells require 5·5 gallons of dilute sulphuric acid, but as the density of the acid is not given, the total weight cannot be calculated. The mean E.M.F. of discharge is taken at 1·9v. and the discharging limit is 1·85.
—	—	—	—	112·2	1·5	—	—	—	

he ascribed to local action between the peroxide and the subjacent lead.

Commenting on this, in their little book, "The Chemistry of Secondary Batteries," Messrs. Gladstone and Tribe point out that the gas is oxygen, and cannot be due to local action, since the gas was evolved whether the peroxide was removed from the supporting plate or not. The application of heat increased the evolution of gas, and the gas was oxygen. Testing the acid between the plates, they always found traces of something which decolourised permanganate, and might, therefore, be hydrogen dioxide or ozone.

Although a very large amount of work has been done on the electrolysis of sulphuric acid solutions, and the general character of the change in the nature of the products formed as the strength of the solution is varied, is well understood, the only references I was able to find to any examination of the acid in a battery were those just given; and therefore I have ventured to bring the results of my own experiments before this Society, not because I consider them a final solution of the difficult problem of the chemistry of the cell, but because I hope that the study of the changes occurring in the electrolyte may help to elucidate some points which are at present obscure.

And now it may be as well to refer briefly to the work which has been done in sulphuric acid.

In 1878 Berthelot* discovered persulphuric acid ($H_2S_2O_8$), and brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that the hydrogen dioxide—which, from Faraday's time, has been well known to be present in sulphuric acid after electrolysis—is really due to the action of this body on the acid. The products of electrolysis vary with the strength of the acid, 40 per cent. acid (density 1300) yielding practically no hydrogen dioxide; while below and above that strength it is present in varying proportions. High-current density, and an electro-negative condition of the electrodes favours their formation.† Persulphuric acid is an unstable body, and begins to decompose as soon as the current which has given rise to it is stopped, and its decomposition is accompanied by the formation of hydrogen dioxide, unless the sulphuric acid is too dilute. Hydrogen dioxide is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases the less hydrogen dioxide it contains, therefore this body is found in estimable quantities long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid is at once decomposed by spongy metal, such as platinum-black, by heat with evolution of oxygen,* and resembles hydrogen dioxide in these reactions, and in releasing iodine from potassium iodide, but, unlike it, has no action on permanganate of potassium or peroxide of lead. The effect of electrolysing a sulphuric acid solution of hydrogen dioxide is simply to increase the rate of the decomposition occurring spontaneously, if a weak E.M.F. is used;† but on increasing the E.M.F., though the rate of decomposition is increased, a little persulphuric acid is re-formed. Subsequent workers have in the main confirmed Berthelot's conclusions. To the oxidising oxygen in the products of the electrolysis of sulphuric acid, Berthelot gave the name of "active oxygen," and as they pass one into the other, and for most purposes connected with a battery it is not necessary to discriminate between them, I have retained it.

Experiments at the General Post Office.

That the nature of the electrolyte affected the behaviour of the cell, was evident from information received from Mr. Barber Starkey with respect to the effect of the addition of sodium carbonate; and it seemed possible that the different behaviour of cells containing this substance was due to its catalytic action on hydrogen dioxide, which is known to be exceedingly unstable in the presence of a trace of alkali; and hence a comparative study of the reactions occurring in cells containing ordinary dilute sulphuric acid, and in those which had been treated on Mr. Barber-Starkey's plan, seemed likely to elucidate the causes of the sulphating during rest, and the high initial E.M.F.—the two features most affected by his treatment.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one half of the secondary cells contain 1 per cent. of sodium sulphate, and the other half ordinary dilute acid, density 1180. He also put at my disposal the records of the behaviour of the cells, and they proved that there was much

* Berthelot. (*Compt. Rend.* 90, 269-275.)
† Richarz. (*Ann. Phys. Chem.* [2] 31, 912).

* Berthelot. (*Bull. Soc. Chim.* [2], 34, 78-81).
† Berthelot. (*Compt. Rend.*, 95, 8-11).

less sulphating with sodium sulphate, as shown by the density of the acid never falling to the same extent as in the plain cells. The following readings taken from short circuited cells with badly broken plates illustrate this. In two cells containing ordinary dilute acid the density of the electrolyte had fallen to 1100, while, according to the last readings before the short circuit occurred, it had been 1170, and 1180 respectively; while in two sodium sulphate cells the density had only fallen to 1180 from 1200 under similar circumstances.

This was strong evidence in favour of the hydrogen dioxide formed in the working of the cell being appreciable in quantity, since if sulphating were only due to local action between the support and the paste, there does not appear any reason why the addition of sodium sulphate should affect it.

Whenever the cells were tested they were always found to contain "active oxygen," which was due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge persulphuric acid is the main constituent; during discharge the quantity of hydrogen dioxide gradually increases; while in a cell which has been at rest sometime there is very little except hydrogen dioxide to be found.

In addition to the tests made on the cells in the electric light and telegraph batteries, I studied the formation of the "active oxygen" during charge and discharge on some cells which were kindly set apart for my special use. The "active oxygen" forms at once on the passage of the current, decreases slightly, and then increases to a little above its first value. Starting either charge or discharge always causes an initial increase, except in the case of cells which have been long idle, when there is a diminution due to the decomposition of the excess of hydrogen dioxide in the acid.

To test whether electrolysed acid was able to reduce pure peroxide of lead, two equal lots of peroxide were taken by weighing one against the other, and put in two flasks. On to each, 100 c.c. of acid, from next the positive plate of a cell at full charge was poured, and this caused the evolution of oxygen, which continued slowly for some days. At the end of a fortnight the amount of peroxide of lead in each sample was estimated, and it was found to have decreased from 97·4 per cent. to 93·94 and 94·04 per cent. respectively.

This appears to explain the well-known deleterious effect of rest on a cell, for although persulphuric acid itself does not reduce peroxide of lead, it forms hydrogen dioxide on standing, which is capable either of oxidising the lead plate to litharge, or of reducing the peroxide plate to the same substance. In each case the litharge is converted into sulphate by the sulphuric acid.

In an ordinary cell in good order the amount of "active oxygen" is small, varying in quantity from about 0·01 grm. to 0·02 grm. per litre; but this means that in a forty-five pint cell (the size used at the Post Office) there was always sufficient to convert from 3·25 grms. to 7·5 grms. of peroxide of lead into sulphate, or to undo the work of one to two ampère-hours charge.

This is not a serious matter if the cells are kept working, as the peroxides are being continually broken up with each reversal of the current, but if the cells stand idle the plates get sulphated, and the amount of "active oxygen" formed in the next passage of the current shows a marked increase.

The figures just given do not represent the total amount of "active oxygen," since the acid absorbed by the plates cannot be tested; but as the acid has more oxidising power the nearer you get to whichever is the positive plate, except at the commencement of discharge, and the total quantity of "active oxygen" increases rapidly soon after breaking circuit, it seems fair to assume that this increase is due to diffusion from the plates of acid which has more oxidising power than that in the body of the cell.

This increase is followed by a decrease which is rapid at first, and then gradually gets very slow, and practically ceases while there is still a fair proportion of "active oxygen" left in the cell.

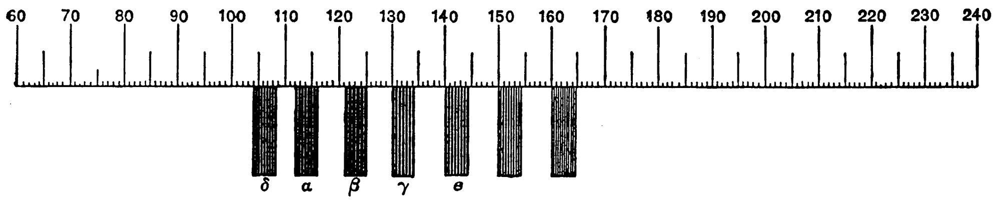
In the sodium sulphate cells the amount of the oxidising agent was usually less than in the plain cells; and the amount of hydrogen dioxide was always so, unless the battery had been at rest for some time, when the conditions were occasionally found to be reversed. This, I suppose, is due to the proportion of "active oxygen" in the form of hydrogen dioxide, at the moment of stopping the current, being greater in the plain than in the sodium sulphate cells, while the latter contain more persulphuric acid. In both cells the hydrogen dioxide present at the time of stopping the current will be reduced on the plates, sulphating the surface, and more or less screening them from further action; but as the sodium sulphate cell contains more persulphuric acid,

the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

The Pink Colour of the Acid.—It has often been noticed, that during charge, particularly with new cells, a pink colour starts from the peroxide plates, and gradually spreads over towards the lead plates, fading away however before reaching them. This pink colour was referred to by Mr. Crompton at a meeting of the Institute of Electrical Engineers on 13th December, 1890, and its origin gave rise to some discussion; so as the acid in many of the cells at the Post Office was pink, I tested it by concentrating it down, neutralising with sodium carbonate, and then igniting on platinum foil, and always got the characteristic green of manganese.

However, lest the manganese should have come from some other source than the pink acid, I compared the absorption spectrum of the acid with that of a solution of potassium permanganate of the same shade of pink, and found they both gave the characteristic bands in the green (Fig. 14). I also found that, using two strips of platinum as electrodes in a solution

Fig. 14.



Absorption Spectrum of Potassium Permanganate.

of manganous sulphate, or any two strips of lead in dilute acid, gave the same colour and the same absorption bands, provided the electrodes were sufficiently far apart to prevent reduction by the hydrogen evolved from the negative. This result was important, for it is well known that the pink colour disappears from the acid in a short time if it is taken from the cell, and as persulphuric acid has no action on permanganate, but hydrogen dioxide decolourises it, this disappearance of the colour shows that the latter is formed.

The Effect of Hydrogen Dioxide on the E.M.F. of a Cell.—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E.M.F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using plain strips as the lead plates. A solution of pure sulphuric acid, density 1180, was used as the electrolyte. The E.M.F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E.M.F.

The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried, with a view of reproducing, if possible, the conditions of a cell, which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E.M.F.

Thus the variations in E.M.F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E.M.F.; and the rise in E.M.F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Professor Ayrton's paper, J.I.E.E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

Conclusions.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of

the oxidised bodies in it, which cause sulphating, without at the same time injuring the plates in other ways.

Nearly all the "forming" baths which have een introduced are baths in which hydrogen dioxide would be broken up as soon as formed, and, perhaps, in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of one per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favourable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gassing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

In conclusion, I must thank the firms who have assisted me in the compilation of this paper by supplying information in response to circulars sent out. This information has also been used in table of types given on pp. 52-53.

DISCUSSION.

Mr. JAMES SWINBURNE said this was a very important paper, but he would not waste time in mere compliments upon its merits. Though Faure was credited with being the first to use the cells which bore his name, he would remind those interested that Kirchoff, an American, used a secondary battery of the same sort, with platinum plates, in which he electrolysed nitrate of lead and got a coating on both plates. He was not quite at one with Mr. Robertson as to the means used in "forming." He tried a number of experiments on this subject in 1883, but in all cases a solution was employed, which would first dissolve the lead and then precipitate it; in fact the idea was to follow the action in the manufacture of white lead. If you took a plain lead plate and eat into it with dilute sulphuric acid, it got coated with peroxide, which protected it. Planté kept reversing the action. This uncovered a new portion of the lead, and so by degrees eat into the body of the plate. He had tried nitric, sulphuric, and acetic acids, various chlorides, and a large number of other solutions; but the great trouble with nitric and other solutions was that traces of material were left in the cell which would eventually eat through the plate and destroy it. The least trace of chloride was fatal; it acted as a sort of carrier, and whenever it was used you failed to get a coherent coating. He got the best results with acetic and sulphuric acids in certain proportions. Acetate of lead was first formed; and as soon as the sulphuric acid got at it, it converted it into peroxide. He thought the idea of heating the plates was due to Brush, who published a very elaborate patent on the subject—a regular treatise—and, amongst other things, he mentioned heat to reduce carbonic oxide; and also that he got a very coherent spongy lead by the use of an alkaline solution. Such solutions did not give lead trees, but a closely adherent sponge. He also tried Dr. Schoop's silica jelly, but was not successful with it. It was very good at first, but soon changed, and was a jelly no longer. He examined some Schoop cells at the Frankfort Exhibition, which looked very like ordinary cells. There was no jelly in them, but there were several clots which, he was told, probably arose from something having fallen in. He also experimented with carbon; but the classical experiments with this substance were made by two Italians, whose names he forgot; and they found that carbon could never be used in any electrolyte from which oxygen was given off. It might be used in a strong solution of chloride, but, even then, it would waste away. He had not gone into the chemistry of it, but he knew that, in time, the carbon turned into a sort of black mud, which had no consistence whatever. He was the first, he believed, to recommend strong acid, and the reason was this: the action of a solution was due to the affinity of the radicle of the acid for the lead; if you had a dilute solution, the acid wanted of course to form a solution, and there was a certain heat formation; but if you used a strong solution you got a lighter E.M.F., because the acid had no longer the same inclination to mix with water, and therefore the inclination to form the lead salt was the stronger. He tried how far this could be carried, and at a certain point he found the spongy lead began to decompose the solution very quickly, and gave off bubbles of hydrogen, and that seemed to be the limiting point. Various theories had been started with regard to the pink solution; Mr. Crompton said it was due to gold;

others said, if so, that was the first instance in which gold had come from a secondary battery. He found he could make the pink solution artificially by leaving peroxide of lead in commercial sulphuric acid, but in pure sulphuric acid it did not occur. The strength of the solution was also of importance; with very strong acid he got a much deeper colour. On testing it he found no trace of manganese, but a good deal of iron. At the same time Mr. Robertson was a skilled analyst, and on that point he was probably right.

Mr. Robertson said he had tried the corresponding iron salt, and found no absorption bands at all.

Mr. Swinburne said he only regretted that Mr. Robertson had not given more information about copper and other cells; people had been working at lead a great many years, and he believed the tendency now was to turn to copper as the cell of the future.

Mr. M. Immisch said he was a considerable user of accumulators, and judging from the number of people who came to him with ideas, there must be something very fascinating in the subject. No end of people came to him with designs, some patented and some not; sometimes with actual apparatus, sometimes wholly imaginary; and his invariable answer was—Send me at your earliest convenience a dozen of your cells at your own price, and if only half what you promise is fulfilled, I can promise you every success. As this had been going on for some years, and though he had given dozens of orders, he had not yet got the cells; the inference was obvious. He himself had fallen under the spell, for, some three years ago, it occurred to him that the amount of active material in the cell was very small in proportion to the total weight, and he thought he would try to remedy that. He procured some solid peroxide plates, and at first the results were marvellous, but in a short time they were not so good, and ultimately he found they would not stand at all. The cells now made were very satisfactory in one way, if they were not so heavy, and if only manufacturers would give them more output in proportion to the weight they would do all that was required. In his experiments he found that the outside contact was at first very good, but it soon deteriorated, and at length there was none at all; so that he came to the conclusion that there was something more intimate, more solid, wanted between the conductor and the active material than he could get.

Mr. Bernard Drake said the D.P. cells were of the Planté type, but they had obtained not only the durability of that type, but the capacity which was supposed to belong only to those of the pasty type. The cells he first issued contained much greater capacity than any they had ever been able to make for the Electric Storage Company: he tested them carefully, and the capacity was very high, but they very soon deteriorated. On trying to produce them on a commercial scale, they met with a number of difficulties, and found that the rusting action which took place in the oxidizing of the plates was very difficult to restrain or to equalise throughout the battery; but by a number of processes since introduced they had overcome this difficulty, and could now form plates by the thousand with a very small percentage of failures. The plates had been in use two years, and with properly-made cells they found no deterioration. It showed how history repeated itself, that after many years' experimenting with pasty plates they found it better to return to the old Planté cells. The rate of discharge was also very satisfactory; the conductor was simply a laminated strip, of a very early type, separated by the thin layers of peroxide formed on their surface, and the current could therefore be taken equally all through the plate, instead of taking it off at one corner, as was the case with peroxide plates alone, or plates of porous material. In the course of his experiments he had entirely confirmed the statement of Mr. Gorham in his paper at the British Association, that the great enemy was sulphate in excess, which produced buckling. If you could stop excessive sulphating there would be no buckling; but if batteries were allowed to run out, and were left under conditions which would produce excessive sulphating, nothing would save them. This was common to all lead batteries, however made or treated. With regard to the specific gravity of the acid, his experience was that it should be varied according to the work required. For lighting a country house, where the cells would be left a fortnight or longer without changing, the specific gravity should be lower, and the voltage lower also, but the capacity of the cell should be greater. With such cells the risk of sulphating would be less. On the other hand, if the cells were to be used, as some had been at a large central station, discharged at about three times the ordinary rate allowed for plates of such a size, then the peroxide was liable to be reduced to the consistency of mud; under such conditions, better results were obtained with a higher strength of acid. With regard to copper cells, he had a good deal to do with Messrs. Elwood and Parker at the time the copper cells were brought over, and the return in proportion to the weight was certainly greater than from lead, but the invariable difficulty was that the zinc appeared to be soluble in the solution, and unless the discharge was taken pretty soon after the charge, the cell ran itself completely out in a single night. So far he believed no one had been able to get over that difficulty, otherwise there would be a great future for copper cells.

Prof. H. E. Armstrong, F.R.S., said this paper marked a distinct epoch in the history of these reversible batteries, as Mr. Robertson very properly called them; the term, secondary battery, threw a sort of halo of mystery round the matter, which had dis-

tinctly retarded progress. This paper would serve to call attention to the great importance of studying the chemical changes going on in these cells, for up to now the matter had been almost entirely in the hands of electricians, and the chemical side had been to a great extent overlooked. The only thing noted was the interaction between sulphuric acid, the lead, and the peroxide. It was true that certain peroxides of hydrogen, and so on, were produced in minute quantity in the cell, but these were not taken much account of, whereas the outcome of the paper seemed to be that these substances which had been so neglected were really the disturbing agents, and that if the work of these cells was to go on with greater certainty and regularity under varying conditions, it would only be by making such alterations in the electrolyte, or otherwise, as would get rid of these perturbing elements. It was not a question of ordinary chemistry; this persulphuric acid to which attention had been called was a substance which the ordinary student of chemistry would probably have no knowledge of; and therefore the very highest chemical skill must be used if these problems were to be satisfactorily solved. During the last few years he had been more than once consulted as to recommending a chemist to those who were engaged in working at these cells, but on making inquiries he found as a rule that the pay offered was such as an ordinary laboratory office-boy would scarcely accept. The idea was that someone was required who would make an occasional analysis of the peroxide, lead, sulphuric acid, or other materials employed; and it was the prevalence of that sort of notion which was answerable for so little progress being made. No chemist had set himself to the problem who had been able to thoroughly master the conditions, and study the question from all sides. If they had set to work in this country, when the cell was first introduced, as the Germans were doing now, the battery would years ago have been in a far better condition than it was now. From the chemist's point of view, he was much inclined to sympathise with what Mr. Immisch said; for if 5 per cent. of the weight of the cell was of any direct use, that was the very utmost, and it did seem strange, therefore, that it could not be very much lightened. It was also interesting to see how they were going back to the Planté form. Mr. Robertson and he had long been of opinion, from a theoretical point of view, that that was the right form, and that the pasty form was necessarily imperfect. The main reason for making the cell so heavy was a mechanical one; it was difficult to secure snfficient strength to prevent the plate from buckling unless such dimensions were employed.

Mr. Desmond Fitzgerald, after complimenting Mr. Robertson on his paper, said he thought no essay on this subject was complete unless some reference was made to the fact that every form of the lead secondary battery was an essentially defective apparatus in one electro-chemical respect—that in fact a great blunder, though probably an inevitable one, was made in their construction, and that blunder was the bringing into contact with each other an electrolyte in two substances, so far apart in the electrical chemical scale as peroxide of lead—almost the most electrically negative element they knew—and lead, which was not far off zinc amongst positives. This at once suggested the question how was it, when all the elements for the production of a voltaic current of great intensity were provided, that the lead support which was in contact with the peroxide was not immediately oxidised and consumed. A partial answer had been given by Dr. Gladstone and Mr. Tribe, and a partial answer also by Messrs. Drake and Gorham. One phenomenon observed, whenever a piece of ordinary lead was brought into contact with the peroxide, was that the sulphating of the solid lead was merely superficial; and this protective superficial coating of sulphate of lead was the princpal reason why this blunder, as he called it, was not attended with more destructive effects. Another cause was, that when you charged a lead support containing an active material which was convertible into peroxide of lead, the support was coated with an impervious layer of peroxide. If you charged a plate carefully, and set it by for some weeks, its capacity remained almost unaltered; but if it were partly discharged, and the peroxide layer were broken, the deterioration of the lead support was very rapid. He had an idea of his own as to the construction of a secondary couple, which would be free from the defect he had pointed out, but it was too late to enter into it, and he would therefore defer a description of the lithanode to some other occasion.

Mr. Shippey wished to say that the Tommasi cell was not the invention of Dr. Tommasi, but of Dr. Woodward, an Englishman living in Toronto. He took it to Paris to show a certain firm, and Dr. Tommasi, not knowing it was patented in France, copied it, and it was now known to the world by his name. He had already stated the facts in the *Electrician* and in the *Electrical Review*. With regard to the cell, No. 3, that was his traction cell, called in Paris the "Atlas." He made a double peroxide plate for the purpose of giving a very light cell, and they were now being made on a large scale, giving 200 ampere hours, and the current could be taken off as required. Cells for lighting and for traction purposes ought to be constructed quite differently. His idea of a cell was a cylindrical one, such as was now being constructed at Messrs. Golding's works. Dr. Woodward had arrived in London, and they would shortly be able to show a cell to the Society of Arts of from 3,000 to 4,000 ampere hours; they were from 6 ft. to 8 ft. high for large central station work, and 3 ft. or 4 ft. diameter, perforated so that the acid through the entire plate and short circuiting was almost impossible. He regretted

that he had not been able to send Mr. Robertson particulars of these cells, but the patents were then pending, and he could not do so, but he should now be happy to give Mr. Robertson any information he required. There were two cells, a combination of the Gibson and the Woodward, which he honestly believed would do all that was required for traction purposes. The weight of the cylindrical cell would be about 35 per cent. less than the E.P.S. The negative plate was formed of lead, which was poured when melted over salt; then the salt was dissolved out, and then it was filled with a combination of various chemicals which he could not mention at present, which did not in any way affect it. The peroxide plate was of the Faure type, so arranged that it could not fall out; and he believed it would not buckle. The lead formed by the salt process was pure spongy lead, which could be cut into strips of any size required.

Mr. W. H. Patchell said he believed the Collins grid was the one seized by the German Government, and turned out of the Frankfort Exhibition, as it was thought to be an infringement of the General Post Office patent, but it was really Mr. Sellon's grid, and was now used for the negative in the General Post-office, but not the discharging plate. The Tudor plates were really horizontal, both positive and negative. In the General Post-office the positive plate was practically the same as the Tudor, but in the negative it was really the No. 4 grid, which gave a perfect negative as far as he knew at present. As mentioned by Mr. King last winter, the negative plates, when some eighteen months or two years old, began to show signs of shrinking, and with the ordinary form of square pellets they would fall away, but with the lattice grid the more it shrank the tighter it became. Dr. Oliver Lodge had pointed out that there were three ways in which a cell could break down; it could fail from a defect in the positive, the negative, or the electrolyte; and he held Dr. Schoop's would break down from the latter. Any jelly or sawdust, or anything which prevented the diffusion of the electrolyte would eventually break down the cell, because the strong acid concentrated on the plate and corroded it.

Mr. Robertson, in reply, said he had taken the Fauré cell as the type of lead-pasted batteries, because the date of the introduction of this cell marked an epoch in the manufacture of reversible batteries. In the Kirchoff cell, the plates were platinum, and therefore it was not altogether representative of lead cells. He had used improvements simply in the Patent-office meaning, and must not be understood as recommending any particular make. He had failed to get any more information about copper cells than he had given. Diminution of weight was of course the great point, and he hoped when they knew more about what happened in a on leaving it to stand at rest, the persulphuric acid would break up, probably, and form hydro-dioxide. With dilute acid, roughly speaking, two-thirds of the acid was hydrogen-dioxide, which was undoing the work you were doing in charging; and the same thing applied in discharging; you increased the rate at which the cell would run down. Increasing the strength of the acid, increased the total quantity of active hydrogen formed, but the proportion of hydrogen dioxide in it decreased. Since the paper was written, he had had an opportunity of making expericell, they would be able to construct them better; at present they were working a good deal in the dark. A very small portion of the weight was active material, and the difficulty had always been that you must have so much more material than you could use. Mr. Drake had confirmed his view that the strength of acid should depend on the work to be done. For a high rate of discharge, he believed in a high specific gravity, because, in working, you did not get such a large proportion of hydrogen dioxide formed, though ments on some of Mr. Crompton's cells, which confirmed the views put forward in the paper from theoretical considerations. The density of the acid in the cells tested, when fully charged, was about 1240, and they contained, practically, no hydrogen dioxide. The difficulty mentioned by Mr. Fitzgerald had been felt for some time, but it was mainly a question of cost. He wished him every success with his lithonode cells. He was obliged to Dr. Armstrong for his appreciative criticism, and to Mr. Shippey for the information he had given.

The Chairman then proposed a vote of thanks to Mr. Robertson. He had had opportunities of watching the care, zeal, and determination with which the author had attacked the question, for, coming as he did with a strong recommendation from Professor Armstrong, he had great pleasure in placing at his disposal all the resources of the Post-office. For years past they had been the most earnest advocates of reversible batteries for various purposes. They had used them for electric lighting, and were now using them to a great extent for the telegraphs. The whole system of telegraphy between this country and the Continent, including the telephone to Paris, was worked by these batteries, and he hoped gradually they would drive out of the field altogether the primary batteries. At present, however, they still had 30,000 of these, so that there was a big field for this very useful apparatus. Before many years were over, he felt sure that these 30,000 batteries would be reduced to one-tenth of the number, by the aid of secondary batteries, and with great economy. Mr. Robertson had not dealt with one very important point, viz., the chemico-mechanical cause of buckling, which was one of the great troubles which chemists ought to attack. He had, however, cleared up many difficult points, and they had certainly learned that whatever was produced by one man as his invention

was immediately claimed by some one else. That showed how able men all over the world were directing their attention to this matter, and endeavouring to solve the mysteries of this instrument, which promised to revolutionize the practical application of electricity. Another point which might have been referred to was the practical use of sodium, of which he might give an instance. In May last it was reported to him that there were twenty-eight 13 E.P.S.L. cells terribly sulphated, all covered with hard sulphate, and various attempts to get them into working order were made without success. Then a saturated solution of carbonate of soda was added, about half a pint to each cell, and at once the whole difficulty disappeared—the battery was got into order and had worked successfully ever since.

The vote of thanks was carried unanimously, and the meeting adjourned.

[Mr. Robertson exhibited some fine crystals of persulphate of ammonium and potassium, prepared by Dr. Marshall in the Chemical Laboratory of Edinburgh University.]

Miscellaneous.

UNIFORM MUSICAL PITCH.

Information has been received from Colonel K. Levi Fuller, secretary of the committee appointed by the Piano Manufacturers' Association of New York, to inquire into the subject of uniform musical pitch in the United States, that the committee have reported to the Association, and recommend the adoption of the French pitch, or *diapason normal* (A 435). The meeting held to consider this report on November 6th unanimously agreed to adopt the recommendation, and this pitch will henceforth be the standard for the United States. It was stated at the meeting that the pitch in general use in New York is A 452, but that this occasionally rises to A 460. Throughout the country it is estimated that as many as 100 different pitches are in use. President Wheelock was authorised to adopt a device to be stamped on all the new forks, which will, in future, be known as the "International pitch;" and it was decided that all instruments sent out by the members of the Association after July 1, 1892, shall conform to that pitch. The New York Committee have collected tuning forks representing the pitch in use at the present time; these have been rated at the Massachusetts Institute of Technology, Boston, by Prof. Charles R. Cross. Prof. Charles R. Cross and W. T. Miller, of Boston, prepared a paper showing the condition of musical pitch in Boston and vicinity. Since the issuing of the committee's circular, October 10th, 1891, twenty-six additional forks have received their preliminary rating, and are yet subject to correction by Prof. Cross. Colonel Fuller further announces that the Massachusetts Institute of Technology have ordered a new tonometer, and Prof. Cross desires to compare all forks thus far rated by the very latest apparatus.

It will be remembered that in 1886 the Council of the Society of Arts announced the abandonment of the Society of Arts pitch in favour of the French *diapason normal.*

SCIENCE AND ART DEPARTMENT.

The Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education have issued the following minute on examinations affected by the Technical Instruction Act, 1889. The minute is dated 12th November, 1891, and signed by Major-General Donnelly:—

"1. My Lords consider the subject of the examinations of the Science and Art Department in Science in relation to the funds applicable to Science and Art and Technical Instruction placed at the disposal of county councils and county boroughs under the Local Taxation (Customs and Excise) Act, 1890, and in relation to the operation of the Technical Instruction Act, 1889.

"2. It appears that the number of candidates presenting themselves for examination in science is already so large—about 190,000 papers in various branches of science were worked at the examination in May last, besides above 14,000 practical examinations—that the machiney of examination and registration is already severely strained. These numbers will, in all probability, soon be so increased as to render it impossible to make satisfactory arrangements for the examination of the candidates at the local centres, or for the examination of the worked papers under any system of central examination.

"3. At the same time, the means recently placed at the disposal of local authorities for providing or aiding instruction seem to render it unnecessary for the Science and Art Department to continue to give direct aid for very elementary instruction in science. Such instruction can now be more effectually organised and maintained locally. It is very desirable that the payments for imparting it should, to some extent at least, not be made on the results of individual examinations. Local authorities, with their local knowledge, and knowledge of local needs and requirements, are in a position to make capitation grants or payments for general efficiency in a manner which a central authority, whose rules must be the same for all parts of the country, cannot adopt; and my Lords feel assured that they may count on having the support and assistance of these bodies in forwarding the arrangements for placing instruction in science—the necessary foundation for any sound technical education—on a satisfactory footing.

"Under these circumstances, my Lords have decided that, after the May examinations of 1892, the payments of £1 now made for the second class in the elementary stage of each science subject shall cease.* An elementary paper will continue to be set in each subject, but the results will be recorded simply as *pass* or *fail*, the standard for passing being about the same as that now required for a first-class, *i.e.*, about 60 per cent. of the marks obtainable.

"5. At the same time, with a view to encourage more advanced instruction, which does not seem to be adequately provided for at present, the payments for the advanced stage and for honours will be considerably increased. The payments on results will be then £2 for a pass in the elementary stage; £5 and £2 10s. for a first or second class respectively in the advanced stage; and £8 and £4 for a first or second class respectively in honours, in each subject of science, and in each sub-division of subject 6, theoretical mechanics, or of subjects 8, sound, heat, and light, with the following exceptions:—the payments for practical chemistry will be £3 for a pass in the elementary stage, and £6 and £3 10s. respectively for a first or second class in the advanced stage: the mathematics will be £2 for a pass in stage 1, £3 and £2 respectively for a first or second class in stages 2 and 4, £4 and £3 for a first and second class respectively in stage 3, £5 and £4 for a first or second class respectively in stages 5, 6, and 7, and £8 and £4 respectively for a first or second class in honours. The payment for Section 1 (geometrical drawing) of subject 1 will remain as at present, 10s.

"6. The payment for attendance in an organised science school will be increased to £1 in the day school and 10s. in the night school.

"7. As it is of great importance to prevent large numbers of wholly unqualified candidates being presented at the examinations, the examiners will be instructed to note the papers of all such as would not obtain above 25 per cent. of the marks, and a deduction will be made from the grant to each school for each such paper sufficient to cover the cost incidental to its examination.

"8. The committee of a science school in a place in Great Britain with less than 5,000 inhabitants which does not receive aid from the local authority, or of any science school in Ireland, will be allowed to continue until further notice on the present system, if they so desire it."

* The payments on the results of the examinations in 1892 will not be effected by this minute.

NOTES AND HINTS ON THE VEGETABLE PRODUCTS OF TROPICAL AFRICA.

By John R. Jackson.

At a time when the products of the soil in tropical Africa are very much in the minds of men, and when companies and individuals are specially interested in developing those resources, the following hints on the nature of the principal vegetable products found in tropical Africa as indicating to the explorer or collector what to look for, and their values when found, will probably be useful.

Two things should be borne in mind, namely, the discovery of new products and the development of those already known, and a knowledge of the botanical affinities of such as are already trade products, will materially help the collector in his search for new sources, whether in the matter of oil seeds, drugs, fibres, or what not. In the following notes the products are classified under their respective commercial heads, and the whole must be looked upon as hints, rather than as an exhaustive list.

India Rubber or Caoutchouc.

The various kinds of African rubber at present known to commerce are furnished by climbing plants belonging to two natural orders, namely, Apocynaceæ and Urticaceæ; the bulk of them, however, are from the first-named order, and from plants belonging to the genus *Landolphia*, of which the following species have been described:—1. *Landolphia owariensis*, extending from Sierra Leone, Angola, the Niger, and the mouth of the Congo, where it is known as the "Mvoochi;" it is the "Abo" of the Niger. 2. *L. florida*, widely distributed over the whole of central tropical Africa, yields a portion of the rubber both from the east and west coasts; native name, "Mbungu." The globular acid fruits are edible, and are known as "Aboli." 3. *L. Kirkii*, an East African species, found on the Zanzibar coast. 4. *L. Petersiana*, also a native of the east coast.

Liberian Rubber.

(*Ficus*, or *Urostigma Vogelii.*) The trees yielding this rubber are known in West Africa by the name of "Abba." The rubber has been valued in the London market at 1s. 6d. per pound, but would realise higher prices if sent home in a cleaner state than it hitherto has been. The District Commissioner at Badagry, writing in 1888, says, "From the trees already in full growth in the bush and towns a considerable export trade could be rapidly established, and systematic planting would develop the trade to almost an unlimited extent."

Any plants belonging to the orders Apocynaceæ, Euphorbiaceæ, or Urticaceæ, may be examined for the presence of rubber, for it is from plants of these three orders that all the rubber of commerce is obtained. The finest Para rubber is furnished by an euphorbiaceous tree, *Hevea brasilienois*, and the Assam and Central American rubbers from urticaceous plants *Ficus elastica* and *Castillia elastica* respectively.

Gutta-percha.

True gutta-percha is obtained from *Dichopsis Gutta*, a sapotaceous tree of Singapore, Penang, Borneo, &c.; the nearest approach to it as an

African product is gutta shea, obtained from the "Shea," "Galam," or "Bambouk" butter-tree (*Butyrospermum Parkii*), a tree 30 or 40 feet high. Shea butter is the solid fat contained in the seeds. It is useful for making hard soaps. Gutta shea is separated from the fat in the course of soap-making, and is found to be present to the extent of from ·5 to ·75 per cent. Though somewhat similar to gutta-percha, it has not yet come into use. A kind of gutta-percha is also obtained from the trunk of the tree in small quantities.

Plants or trees belonging to this order—Sapotaceæ—should be examined for the milky juices of their trunks, and the seeds for the fats or oils they contain. Sapotaceous seeds may be recognised by their shining brown hard skins and broad dull scar, which usually extends the whole length of the seed.

[To be continued.]

General Notes.

St. Petersburg Exhibition of Life-Saving Appliances.—It is announced in the *Board of Trade Journal* that an Exhibition of appliances for the prevention, detection, and extermination of fires, and of life-saving apparatus, will be held at that capital in April, 1892, and that further particulars can be seen, if desired, on personal application to the Commercial Department of the Foreign-office.

Chicago Exhibition.—The Berlin correspondent of the *Standard* gives the following quotation from the *Reichszanzeiger* :—" The question of Germany's participation in the International Exhibition at Chicago is now viewed by German employers of labour with different eyes. Up to a short time ago, the representatives of many branches of industry most deeply concerned in the American trade persisted in an unfavourable attitude, but now the conviction that abstention would cause great injury to German industry, and that it is a duty of honour to take care that German industry be worthily represented, is becoming general."

Italian Industrial Museum.—The *Regio Museo Industriale Italiano* was founded at Turin, in 1862, when that city was still the capital of Italy; and when the seat of Government was removed to Rome, it was, although a national establishment, continued at Turin. It has grown into a large institution, in which instruction in industrial engineering, chemistry, physics, mechanics, &c., in all the higher branches of technical education is carried out. One of the departments is a Commercial Museum, in connection with which is an office for collecting information from Italian Consular agents, transmitted through the Italian Foreign-office at Rome. The collections of raw products, and the manufactures produced from them, occupy 45 rooms, and the Educational Department, which contains an assortment of objects from all civilised countries, especially British and Italian, occupies ten rooms. The collections have been largely added to by contributions from British donors. The Museum publishes an *Annuario*, the last issued being for the scholastic year 1890-91.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

December 9.—James Dredge, "The Columbian Exposition at Chicago, 1893." The Attorney-General, M.P., Chairman of Council, will preside

December 16.—General Pitt Rivers, "Typological Museums, as exemplified by the Pitt Rivers Museum at Oxford." Professor Flower, C.B., Director of the Natural History Museum, will preside.

Papers for meetings after Christmas :—

"Spontaneous Ignition of Coal, and its Prevention." By Prof. Vivian B. Lewes.

"Burning Oils for Lighthouses and Lightships." By E. Price Edwards.

"Dust, and How to Shut it Out." By T. Pridgin Teale.

"Iceland." By T. Anderson.

"Ancient and Modern Art Pottery of Japan." By Ernest Hart.

"Artistic Treatment of Jewellery : The Jewel and Address Caskets." By I. William Tonks.

"Agricultural Banks for India." By Sir William Wedderburn, Bart.

"The Scientific Value of Lovibond's Tintometer." By F. W. Edridge-Green, M.D.

"The Agricultural Needs of India." By Dr. J. Augustus Voelcker.

"Travels in Indo-China." By Lord Lamington.

"The Woodcuts of Gothic Books." By William Morris, M.A.

"The Fisheries Department : its Position and Prospects." By J. W. Willis Bund.

"The Congo State." By Captain W. Lovett Cameron, R.N., C.B.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday afternoons, at Half-past Four o'clock :—

January 19, February 16, March 15, April 5, 26, May 24.

Indian Section.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock :—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 26, February 23, March 8, 29, April 12, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

A. P. LAURIE, M.A., "The Pigments and Vehicles of the Old Masters." Three Lectures.

LECTURE II.—DECEMBER 7.—The pigments used in the 15th century, and their preparation and properties, with some account of the methods of painting.

LECTURE III.—DECEMBER 14.—The mediums used by the Old Masters, in tempera and oil painting. The preparation of the oils and varnishes, and the properties of the same.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by PROFESSOR JOHN M. THOMSON, Sec. C.S., on the "Three States of Matter: Solid, Liquid, and Gaseous," on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 7.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. P. Laurie, "The Pigments and Vehicles of the Old Masters." (Lecture II.)

Farmer's Club, Salisbury Square Hotel, Fleet-street, E.C., 6 p.m. Paper on "The Working of the Local Government Act, 1888," by the Chairman.

Royal Institution, Albermarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town Hall, 7½ p.m. Mr. G. M. Lawford, "The Drainage of Town Houses."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Watson Smith, "A Contribution to our knowledge of the Soluble and and Resinoid Constituents of Bituminous Coals." 2. Dr. Murray Thompson, "The Salt Industry of India."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. H. Bedells, "Party and Party-Fence Walls."

Geographical, Uuiversity of London, Burlington-gardens, W., 8½ p.m. Mr. D. G. Hogarth, "Passes of the Taurus and Anti-Taurus."

Medical, 11. Chandos-street, W., 8½ p.m.

Victoria Institution, 1a, Adelphi-terrace, W.C., 8 p.m. Paper by Rev. W. St. Clair Tisdall.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edmund Gosse, "Ibsen and his Critics."

TUESDAY, DEC. 8 ..Farmer's Club, Salisbury Square Hotel, Fleet-street, E.C., 5½ p.m. Annual General Meeting.

Medicul and Chirurgical, 20, Hanover-square. W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Henry Gill, "The Sale of Water by Meter in Berlin."

Photographic, 5a, Pall-mall east, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Osbert H. Howarth, "The Toltec Relics of Teotihuacan, Mexico." 2. The Rev. B. Danks, "Burial Customs of New Britain."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Sir Edward Braddon, "Australasia: a Vindication.

WEDNESDAY, DEC. 9 ... SOCIETY OF ARTS, John-street, Adelphi, W.C. 8 p.m. Mr. James Dredge, "The World's Columbian Exposition at Chicago in 1893."

Geological, Burlington-house, 8 p.m. 1. Prof. J. F. Blake, "The Rocks Mapped as Cambrian in Caernarvonshire." 2. Mr. Wm. Shone, "The Subterranean Denudation of the Glacial Drift: a Probable Cause of Submerged Peat and Forest Beds." 3. Mr. A. C. Nicholson, "High-Level Glacial Gravels, Gloppa, Cyrn-y-broch, near Oswestry."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. A. E. Tagliaferro, "Architectural Photography."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Central Chamber of Agriculture (at the House of the Society of Arts), 11½ a.m. Annual Meeting.

THURSDAY, DEC. 10...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. Bridge, "An Hour with Mozart." (Illustrated.)

Institute of Architecture, Science, and Art, Dundee, 8 p.m. Mr. F. Grant Ogilvie, "Electric Lighting of Houses."

Electrical Engineers, 25, Great George-ssreet, S.W., 8 p.m. 1. Annual General Meeting. 2. Mr. W. H. Preece, "The Specification of Insulated Conductors for Electric Lighting and other Purposes."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8½ p.m. Mr. F. W. Mills, "Practical Methods in Photographing Interiors."

FRIDAY, DEC. 11...Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. C. H. Wordingham, "Meters for Recording the Consumption of Electrical Energy."

Astronomical, Burlingtion-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, DEC. 12...Botanic, Inner Circle, Regent's-park, 3¾ p.m.

Journal of the Society of Arts

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FRIDAY, DECEMBER 11, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

Mr. A. P. Laurie delivered the second lecture of his course on "The Pigments and Vehicles of the Old Masters," on Monday evening, 7th inst. The lecturer fully described the various pigments in use in the 15th century, ending with a special description of the lakes.

The lectures will be printed in the *Journal* during the Christmas recess.

FOREIGN AND COLONIAL SECTION.

A meeting of the Committee of the Section was held on Thursday, 3rd inst., at 4.30 p.m. Present: Francis Cobb, Treasurer of the Society, in the chair; Sir Edward Braddon, K.C.M.G.; C. M. Kennedy, C.B.; Sir Erasmus Ommanney, C.B., F.R.S.; with Sir Henry Trueman Wood, Secretary of the Society, and E. Cunliffe-Owen, C.M.G., Secretary of the Section. The programme of papers to be read during the present Session was discussed.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, Dec. 9, 1891; The Attorney-General, M.P., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Braddon, Sir Edward N. C., K.C.M.G., 5, Victoria-street, S.W.
Cowan, Thomas William, 31, Belsize-park-gardens, N.W.
Fitzgerald, Prof. George Francis, M.A., F.R.S., Trinity College, Dublin.
Hotz, A. P. H., Leacroft-house, Staines.
Potter, Walter F., 440, Kingsland-road, N.E.

The following candidates were balloted for and duly elected members of the Society:—

Baird, John, Knoydart, Isle Ornsay, N.B.
Brettell, J. Henry, 11, Portman-street, W.
Butterworth, William, United States Patent-office, Washington.
Patterson, Myles, Oriental Club, Hanover-square, W.
Proctor-Sims, Richard, M.Inst.C.E., Bhavnagar. Kathiawar, India.
Wilson, James, M.E., Old Forge, Dunmurry, Co. Antrim.

The paper read was—

THE COLUMBIAN EXPOSITION OF 1893.

By James Dredge,

Member of Council; Member of the Royal Commission.

I.—Introduction.

I had the honour of appearing before you, a year ago, and of making the first public address on the subject of the Columbian Exposition of 1893 which had been delivered in Europe. On that occasion our Chairman suggested that, at similar intervals, until the close of 1893, it would be of interest to prepare other papers on the same subject, in which would be recorded the progress made during the preceding twelve months, and ultimately the measure of success achieved by the Exposition. Acting on this suggestion, I venture again to claim your attention, while I endeavour to describe the character, the actual condition, and the coming prospects, of the great work now rapidly advancing in Chicago. You may remember that, at the date of my previous paper, the smoke had scarcely cleared away from the battle-field at Washington, where different cities had been contending for the prize, and upon which Chicago remained the victor. It cleared away to disclose other and minor storm clouds, impending local difficulties, as well as broader differences between the Government representatives and those of the municipality. Then the Chicago Exhibition scheme tossed in troubled waters, as stormy as those of Lake Michigan. From the Eastern States, contempt and ridicule were poured upon it, and motives, that lay deeper than

those of angry disappointment, materialised themselves in a persistent flight of malicious telegrams and reports, intended to depreciate the prospects of Chicago and to prevent European co-operation; for European co-operation might mean to these intriguers extensive damage to American trade. These evil times are happily far enough removed to enable us to judge clearly of the attitude adopted by the people of Chicago, and by the gentlemen they have chosen to direct the affairs of the Exhibition; of their energy, determination, self-sacrifice, and steady advance in the face of great and discouraging difficulties. It may be affirmed with confidence that whereas, a year ago, the prospects of the Columbian Exposition were full of doubt and uncertainty, they are now assured; that the misunderstandings, jealousies, and suspicions that then suggested the possibility of shipwreck have been swept away; and that the executive, which twelvemonths since were only amateurs in exhibition matters, have so fully grasped the general aspect, as well as the innumerable details of the problem, that they have passed the stage of apprenticeship, and have proved themselves capable of filling the onerous position assigned to them. A year ago the general plan and organisation of the Exhibition were vague; to-day they are settled, down to minute points of detail: then, the designs for the buildings had not been prepared; now, all the important contracts have been let, and the whole area of Jackson-park is crowded with thousands of workmen. A year ago, in this country and on the continent, so far as the Columbian Exposition excited comment, it was that of contemptuous indifference, or of hostility emphasised by the effect of the McKinley tariff on the commercial mind, which had not realised that this weapon is a two-edged sword, as liable to wound those who wield it as those whose interests it is intended to strike. To-day the importance of the Exhibition is recognised; its extent and magnificence are no longer questioned; it has taken rank by anticipation as one of the great International Exhibitions of the century; and its potential commercial usefulness to British manufacturers is beginning to be understood. All these things are much to have achieved in so short a time, but more than that has been done. A Commission, representing the American Government and the Chicago directory, visited this country in July last, and were received in a manner that gave the greatest satisfaction to themselves and throughout the United States; their reception here undoubtedly prepared the way for their successful Continental mission. They visited almost every European country, and in each were received with welcome. France and Germany, Russia, Austria and Italy, Scandinavia, Belgium, and Holland—all these countries dismissed them with words of encouragement and promises, which were in most cases followed by action, and in all were sincere. The visit of these gentlemen to London was extremely well timed; it coincided with the appointment by the Government of a Royal Commission, and the special honour was shown to this Society of selecting its Council to constitute that Commission. I suppose we all of us realise the benefit of this selection to the Society; the distinction that has been shown it, and the value that it will be in the future, if the Council are enabled—and of that I think there can be no doubt—to report some three years hence that they have successfully acquitted themselves of the trust placed in them.

Even of more importance than the visit of the American Commission to London, was that of the representatives of the British Commission to Chicago last September. You will perhaps have read the report upon that visit, and will I trust agree that we all have the fullest reason to be satisfied with the prospects of the Exhibition, and to be more than content with the warm sympathy and kindliness, expressed both in Washington and in Chicago, towards this country. That this kindliness and sympathy were not empty forms of speech, was proved by the fact that in each instance the demands made on behalf of British exhibitors were granted to the fullest extent. The executive have, as a matter of course, laid down the wise rule to treat foreign applicants for participation without favouritism, and in the order of their application, but I think we may claim to be an exception to this rule, and to have commenced our connection with the Exhibition under conditions of friendship and goodwill which rise superior to the rigid limits of regulations, and call for our brotherly co-operation to aid in, as well to compete at, the Columbian Exposition of 1893.

When the Act of Congress was passed legalising the Exhibition as a Government undertaking, care was taken that, while the national Treasury was not hampered with liability, power was reserved for national supervision and control upon several very important points; and to take charge of the

Government interests a large Commission, composed of two members of Congress from each State in the Union, was appointed. The chief duties of this body were: to approve of the designs of the buildings and of the site selected; to satisfy themselves that the undertaking was on a financially sound basis; to compile the classification of exhibits; to allot space to home exhibitors and to foreign nations; and to control the proceedings of the juries, which are to be regulated by a system which they shall decide upon. Like many other committees, this national Commission entered on its duties with great enthusiasm and in full force of numbers, but it was soon found, as is not unusual, that the body was too large to be manageable, and before long its functions were delegated to a very small number of its members, who, with an equal number of the Executive Directory, constitute the supreme body, or Board of Control. The Government portion of this Board is represented permanently by the Director-General, Colonel George R. Davis, who has charge, subject to the Board, of the various matters above referred to, in which the Government hold control.

All executive matters relating to construction and management, before, during, and after the Exhibition, are vested in the Exhibition Executive, appointed by the Board of Directors, representing the guarantors of the city of Chicago, who have become responsible, in the first place, for the minimum sum of ten millions of dollars, and practically for the unknown supplementary expenses which most certainly will be incurred. As a matter of course the original estimates have been already largely exceeded, for the scheme of the Exhibition has grown under the hands of its creators, and the controlling bodies have applied to the central Government for assistance, not in the form of a grant, but as a loan, secured upon the future assets of the undertaking, rather than throw a further burden upon the citizens of Chicago who have made such large advances. With this part of the scheme we have nothing to do, though we may remark in passing that, in one way or another, the funds required, no matter how lárge they may be, will be forthcoming, whether from the national exchequer or from private subscriptions, and that in no event can any financial difficulty intervene—at least in no event for which a forecast is possible.

This part of the subject would not be complete without a reference to the organisation by which the Exhibition work is controlled. The Chicago Board of Directors consists of forty-five members, the officers of which are:—President, the Hon. W. H. Baker; Vice-Presidents, Messrs. T. B. Bryan and Potter Palmer; Secretary and Solicitor-General, the Hon. Benjamin Butterworth; Treasurer, Mr. F. Seeberger; Auditor, Mr. W. K. Ackerman; and Traffic Manager, Mr. E. E. Jaycox. The directory is divided into a number of working committees, of which the most important are the Executive, Finance, Grounds and Buildings, and Ways and Means. The Bureau of Construction comes under the immediate control of the Executive; the head of this very important department is Mr. D. H. Burnham, Chief of Construction, under whose direction all the details of the buildings are prepared, and the work carried out. In the same department are the landscape gardeners, Messrs. Olmstead and Co., whose work will be referred to later.

On the Government branch of the control are the officers of the Government Commission, nine in number, including the Director-General, Col. George R. Davis, who is the executive officer for the Commission. In his charge are the various departments of the Exhibition, chiefly referring to the arrangement of exhibits, installation, &c. The names of these departments and of their respective heads are as follows:—(1) Agriculture, Mr. W. I. Buchanan; (2) Horticulture, Mr. Saunders; (3) Live Stock, Mr. W. I. Buchanan; (4) Fisheries, Mr. J. W. Collins; (5) Mines and Mining, Mr. F. J. V. Skiff; (6) Machinery, Mr. Robinson; (7) Transportation, Mr. W. A. Smith; (8) Manufactures, Mr. J. Allison; (9) Electricity, Mr. J. P. Barrett; (10) Fine Arts, Mr. H. C. Ives; (11) Liberal Arts (of this the chief has not been appointed); (12) Ethnology, Professor F. W. Putnam; (13) Forestry, Mr. W. I. Buchanan; (14) Publicity and Promotion, Mr. M. P. Handy; (15) Foreign Affairs, Mr. W. Fearn.

Besides the foregoing committees and directors, there is a Board of Reference and Control; a Board of Lady Managers for the Women's section; and the Committee for the great series of Congresses to be held in connection with the Exhibition in 1893.

Finally come the members of the Board of Control for the United States exhibit, eleven in number, and all of them distinguished men. They are: for the Department of State—Mr. S. A. Brown, Chief Clerk of the State Department; for the Treasury Department—Mr. A. B.

Nettleton, Assistant Secretary; for the War Department—Major C. Comly; for the Navy Department—Captain R. W. Meade; for the Post Office Department—Mr. A. D. Hazen, one of the Assistant Postmasters-General; for the Department of the Interior—Mr. H. A. Taylor, Commissioner of Railroads; for the Department of Justice—Mr. E. J. Foster; for the Department of Agriculture—Mr. E. Willits, Assistant Secretary of Agriculture, and who is also chairman of the Board; for the Smithsonian Institution—Dr. G. L. Goode, assistant-secretary of that institution; for the United States Fish Committee—Mr. J. W. Collins; and for the Latin-American Department—Mr. E. W. Curtis. It will be seen from this list that every department of State will be efficiently represented in the Government buildings. Besides the various agents who have been dispatched to different parts of the world by the Executive as well as by the American Government, it may be mentioned that the Exhibition authorities are permanently represented in England by Mr. R. S. McCormick, recently Secretary at the American Legation in London, and whose offices are at 72, Victoria-street, Westminster; while several delegates have been dispatched to Europe by the Treasury Department in Washington to render such assistance and information as may be in their power, to the various Royal and other Government Commissions that have been, or will be, appointed in Europe to look after the interests of foreign exhibitors.

The names of many other gentlemen actively engaged upon the Exhibition in Chicago will be given hereafter in the course of this paper, and if they are omitted it will be due to oversight and not intention on my part. Just now public attention is concentrated on the work in progress at Jackson-park, and to this subject the present paper will be mainly devoted.

II.—The City of Chicago.

Before referring to the Columbian Exposition, it may prove of some interest to you this evening if I attempt to give a slight idea of the appearance and general characteristics of the city of which we are now hearing so much. It is said that a United States engineer officer, at the beginning of the century, who was employed upon the survey of the great lakes, reported that there was only one spot on which it was impossible to build a city on the banks of Lake Michigan; it is just on this spot that Chicago is situated. There was, however, good reason for this prophesy. A century ago the pathless wilderness terminated here in swamp and morass—land mingling with water like an unfinished fragment of creation; the sluggish, fever-laden creek, fed from the lake or from the inland water-shed, and altering the direction of its current with the season and the water level, spread over the adjacent low-lying lands and helped to complete the scene of hopeless desolation. But even two centuries ago this forbidding stream had its uses; the spirit of successful colonisation was then active in France, stimulated and carried forward by the fervour of religious enthusiasm that drove earnest men into the remote places of the earth, bearing aloft the Cross and planting strange truths in savage minds. These were the explorers and pioneers who have left traces of their work behind them through the broad lands that separate the lakes from the Gulf of Mexico; whose monuments remain in the names of cities and villages throughout Illinois and Louisiana; and in the names of many of the principal streets of the City of Chicago. Marquette and Joliet—priest and soldier—discovered the Chicago River late in the 17th century, and tested its usefulness as a way of reaching the Mississippi by the portage over the low divide that opposes a barrier to the chain of lakes from discharging into the Gulf of Mexico. The first survey of the district was made by Joliet in 1673; his companion died of malaria after a brief attempt to proselytise the local Indians. In these early times the name of the site was much the same as now; it had two meanings, according to whether the word was used by one or other of the tribes that frequented the unalluring spot—"Onion" or "Polecat." The fate of Marquette appeared through several generations to serve as an inducement for others of his devoted calling to seek malarial martyrdom on the banks of the Chicago Creek; and in their wake followed the traders, to traffic with the natives, but not to stay. The first permanent resident appears to have been a fugitive slave, who in the course of time did quite a handsome business as a fur trader. Meanwhile, troublous times were the portion of North America; wars with the Indians; French, Colonial, and British wars; and finally, the revolt against English despotism that laid the firm foundations for a great nation. It was only after the genius of Washington had brought the war of Independence to a triumphant conclusion, that the site of Chicago attracted any attention; this was

prior to the acquisition of Lousiana by the United States through purchase from France. British influence among the Indians around the Lakes was strong, and was exerted to the damage of the new Republic. In the words of an American writer, "It became necessary, with the acquisition of new territory, that the United States should make some demonstration of its strength, in order to counteract the pernicious effects of England's tactics." This demonstration took the shape of a fort that was built in 1804, and formed a nucleus for a small group of traders and other hardy pioneers to gather round it for mutual protection. So matters remained till the war of 1812, when a wholesale massacre of the garrison and the handful of settlers took place; the fort and dwellings were destroyed, and the silence of the wilderness was restored. Two years later, however, Fort Dearborn was rebuilt, the power of the Indians was broken, and a settlement was again attempted, this time with success, so that when—in 1818—Illinois was admitted as a State into the Union, Chicago was quite a thriving village. Civilisation—embodied by the tax collector—appeared in 1823, when, on behalf of Fulton County, in which Chicago was then situated, the sum of 11·42 dollars was obtained, showing that the rateable value of property at that time was 2,284 dollars, or less than £500. The real founders of Chicago appear to have been the Illinois and Michigan Canal Commissioners, a powerful corporation early in the century, and who possessed powers to lay out towns on the lands that had been assigned to them by the Government. Thus it came about that "Fort Dearborn Settlement," as the village had been called, passed out of existence, and the town of Chicago was called into being. The first plan of the new town and its surroundings (long since absorbed by rapid growth) was issued in 1830 on August 4th.

The history of the first few years of Chicago is that of all new settlements in the wilderness, with the exception, perhaps, that its progress, though at first slow, never received a check. In 1832, the first business building was erected by Mr. F. W. Peck, the father of one of the most prominent and wealthiest citizen families of Chicago to-day. About the same time the industry, now so famous—that of pork packing—was inaugurated, and, in 1833, the population had increased to 350, by which time it was considered that the settlement had developed sufficiently to be incorporated into a town. The United States Government, as early as 1833, commenced the harbour works, which have since assumed such large proportions, and it is worthy of note that when there were but 350 inhabitants, no less than four churches and four taverns had been constructed. It is not therefore surprising to learn that the first legislative efforts of the new town were directed towards the closing of the latter on the Sabbath, and the proper observance of that day; or that fines, that helped to swell the municipal exchequer, were levied for the infraction of these laws. The ambitious inhabitants of that time soon grew dissatisfied with being mere townsmen, and, in 1837, they succeeded in raising Chicago to the dignity of a city. In that year, when the first census was taken, it was found that the population had increased to a total of 4,170 persons. From this date the growth of the city of Chicago was phenomenally rapid, but it would occupy too much space, and be beside the present purpose, to attempt to sketch its history. I may therefore pass on at once to notice in a few words the fire of 1870, which destroyed more than three square miles of buildings, and rendered 98,500 persons homeless. This catastrophe was the turning point in the history of Chicago, for terrible as the visitation was, it swept out of existence, along with numerous fine and permanent buildings, thousands of wooden structures, and at the same time obliterated some miles of narrow streets. The total loss was estimated at nearly forty millions sterling. Modern Chicago dates from this conflagration, and ten years after it had occurred all visible traces of the devastation had disappeared, and the new era of construction, of which the city is so proud, had commenced.

To-day Chicago covers an area of 180 square miles; it has a population of over 1,200,000; there are 2,200 miles of streets within the city limits; there are 395 miles of street railways; and over 2,000 acres of public parks. Thirty-five district railroad companies have station accommodation in the city, and it is claimed that these railroads, with their branches and immediate connections, have a total length of more than half the mileage of all the ways in the United States. The Chicago river and its branches are crossed by sixty-one bridges, all, or nearly all, of which are turning bridges, so as to accommodate the constant movement of ships up and down the river. There are in addition several tunnels, by which the street traffic can pass without interruption, and this means of communication is on the

increase. Like most American cities, Chicago is laid out on the convenient but monotonous rectangular system. Its most important thoroughfare is State-street, which runs from north to south for a distance of 18 miles, or only three miles less than the distance between London and Windsor. To give you an idea of the dimensions of the city, I may add that 87th-street, which runs from east to west across its widest part, is 10½ miles long. Someday the ring of boulevards will be the glory of Chicago, and will add another to her many claims of superiority over the remainder of American cities. Some of these really magnificent roads are completed, and are lined with miles of handsome residences that attest the wealth and refinement of the citizens. When completed, this succession of boulevards will connect the twenty-eight parks which give to Chicago her favourite title of the garden city; I cannot say what will be the length of this system of boulevards, but it will certainly be longer than any other ring of boulevards in the world.

The number of houses added to Chicago last year would, if placed side by side, have made a solid frontage 51 miles in length. They numbered 11,640 structures, and cost nearly ten million sterling; this will give some idea of the rate of development of the city.

There are several peculiarities connected with the buildings of Chicago, to which reference may be made, as I think they are without parallel. One of these is the curious custom of moving houses, generally from a costly to a less expensive site. This operation is not by any means exceptional, as will be seen from the fact that during the year 1890, no less than 1,710 houses, with a total frontage of 33,922 feet, or about six miles, were shifted from one location to another. Most of the buildings so moved were of timber, but many of them were of brick, and some of them no less than four stories high; the average frontage for these transported dwellings was about twenty feet. The profession of house moving is a very old one in Chicago, as also is that of raising structures bodily to a sufficient height for allowing an additional story to be added at the ground level.

It would, however, be a task beyond the powers of the most enterprising contractor to shift or to raise the modern typical buildings, which claim to be larger and higher than any in the United States; and it would appear that there is good reason for this claim. Take, for example, the Masonic Temple, now nearly completed, which measures 117 feet by 114 feet, and has a height of 265 feet, divided into twenty storeys. Another towering structure, euphoniously styled "a new sky-scraper," is being reared, and which, although it will only have sixteen storeys, is intended to eclipse anything that has yet been attempted; and there are many of these enormous piles, not so lofty as those just referred to, and others still higher, either designed or commenced. Of those completed, the most remarkable are the new Chamber of Commerce building, with 500 offices, Temple Court with 400, the Mono building with 300 rooms. The Manhattan contains 900 offices; the Rookery more than 600; the Tacoma building has 500 rooms; and many others not much smaller. There are large numbers of such structures in the city, which impress by force of their size rather than by their architectural beauty, and it is refreshing to the uneducated western eye to turn to the older structures of importance, such as the City Hall and the Post-office building, which latter is to be pulled down ere long, and is referred to in the most recent guide to Chicago as "a great structure, but old fashioned." Its erection was commenced after the great fire in 1871.

The peculiar conditions of the soil have necessitated a special form of construction for all these lofty buildings. Beneath the surface ground, which consists chiefly of sand and extends to a depth of about 14 feet, there is a wide stretching bed of clay from four to six feet only in thickness. This clay is carried by some 40 feet of saturated soil, in many places little better than mud, and beneath is a solid bed of clay extending to a great depth. It was necessary either to found the buildings upon piles carried into the lower stratum, or to depend upon the thin bed of top clay. This latter course is now universally adopted, the greatest care being taken not to overload the apparently slight support which is available. It is of course impossible to have any deep basements, and, as said before, a novel form of construction is adopted. No continuous foundations are employed, but the piers or columns which support the building rest upon isolated bearings on the clay. These bearings consist of longer or shorter lengths of steel beams, placed close together and superimposed in several tiers, the interstices being filled with cement. The superstructures are, in nearly all cases, framed with steel columns, girders and bracing; the walls are mere shells

of stone, or brick, or terra cotta; they add nothing to the strength of the building, and merely act as screens; partitions are constructed of hollow terra cotta tiles; the floors of arches of the same material laid between the girders. All columns are protected by shells of terra cotta bricks, air spaces being left between them and the metal, in order to decrease the danger from fire by the presence of a non-conductor. In this way buildings are raised storey above storey, until they arrive at the enormous heights above mentioned. Instance the Masonic Temple with its twenty storeys, twelve or fourteen of which are arranged as spacious shops, the remainder being devoted to offices or for Masonic purposes; one peculiarity in this building is that all the domestic offices —lavatories, barber shops, &c.—are placed at the summit of the building. Of course a staircase is of but little use in such a structure; it is practically replaced by elevators, of which a dozen or more are to be seen in constant operation. It is worth noting that these elevators, which are run at speeds entirely unknown in this country, are worked like express and local trains, some stopping at every floor, and others at only certain stories. It is claimed that these monumental structures are cheaper and more convenient than those of lesser height: the ground within the centre of the city is so costly as to preclude the possibility of erecting ordinary buildings, and the undoubted advantage cannot be disputed that anyone who has business in the city can transact it within a very short distance of the Chamber of Commerce. Despite this, however, I am informed that a reaction is setting in against these lofty buildings, and even that legislation will before long interfere with their extension. A new development, too, is in progress in another direction; I have referred to the narrow margin of depth available for buildings founded on the upper clay. But now one building at least is to be constructed, the walls of which are to be taken down to the lower clay stratum forty feet beneath. This will, of course, involve very heavy masonry works to hold back the plastic soil that underlies Chicago; on the other hand, if the difficulties connected with this method can be overcome, a basement forty feet in depth will be obtained, and so much additional use will be made of the costly ground. The recent great buildings in Chicago are essentially engineering structures, not only as we have seen with regard to a system of construction, but also in respect to internal appliances. In all of them a very large amount of steam power is required for numerous purposes, such as electric lighting, heating, and ventilation, working elevators, lifting sewage, &c.

The sewage question is a very serious one in Chicago, and during the last thirty years the difficulties have been controlled, more or less successfully, by a series of expedients, which, like so many other things in the great city, are strikingly original. In early times, when the population was small, the discharge of sewage into the river, and thence into the lake itself, was not a matter of vital importance, and did not interfere with the water supply from the lake. In 1868 the very novel method of obtaining an uncontaminated water service, by tunnelling two miles beneath the bed of the lake and constructing an inlet at that distance, was successfully completed. The same system is now being imitated on a larger scale, a four mile water supply tunnel being nearly finished. For many years it has been illegal to discharge sewage into Lake Michigan, and theoretically this is avoided. It has been explained how, in the natural order of things, the Chicago river flowed sometimes into the lake, and how sometimes the lake flowed into the Chicago river. To establish this latter order as a fixed *régime* is the basis of the means adopted for preventing contamination of the lake water. The sewage is allowed to flow into the Chicago river—of itself a recognised evil and a standing menace to the public health. In order to reduce this evil as far as possible, very powerful pumping engines are kept in constant operation, raising the water from the river and discharging it into a canal which flows southward to the Illinois river, and thence to the Mississippi. The volume of water thus raised is sufficient at all times of the year to ensure a steady flow of the lake into the Chicago river, and the purity of the former is thus practically assured. But the fact remains that the river is nothing more nor less than an open drain that receives the sewage from the populous and busy city. The evil is so fully recognised that, in a very short time, works will be commenced by which the imperfect system of pumping will be exchanged for a rapid flow by gravitation of the Chicago river to the Mississippi. Fortunately the levels are so favourable that, considering the magnitude of the work, the necessary outlay will be moderate, and will not only alter the sanitary condition of Chicago, but will convert the city into a seaport. This scheme, which is now in

the hands of a drainage commission, is the construction of a canal, which shall be large enough to serve as a ship canal, and which, commencing at the Chicago river, will terminate at one of the branches of the Mississippi, and will thus open direct communication to the Gulf of Mexico. The levels of this new waterway will be so arranged that an enormous body of water will flow steadily from the lake southward, and thus restore to a minute degree the *régime* of that geological period when the Gulf of Mexico, and not the St. Laurence, received the overflow from the great lake system of North America. It will be gathered from what I have said, that in consequence of the slight variations in level afforded by the flat plain on which Chicago stands, only a very small proportion of the drainage can flow by gravity into the river. For this reason it has been found necessary to adopt means for raising the sewage from each building in which a basement exists, and in the great structures of which I have endeavoured to give you an idea, independent pumping installations are employed for this purpose. It may be of interest to mention that in almost every case the Shone system is in operation, and, I am informed, with perfect success.

No sketch of Chicago would be complete without a reference to the somewhat ghastly industry which is the corner stone of its prosperity—the great stockyards and packing works. To give some idea of the extent of this business, it may be mentioned that during 1890 more than 2,000,000 of cattle and nearly 6,000,000 of hogs were slaughtered; 311,557 railway cars were needed to bring these animals to the stockyards, and their estimated value was about £46,000,000 sterling.

The principal stockyards are situated about five and a half miles from the centre of the city in a south-westerly direction; they were opened in 1865, and occupy an area of 400 acres, half of which is devoted to the yards, while the remainder is occupied by railroad and sidings. Accommodation is provided for 20,000 cattle, 120,000 hogs, and 15,000 sheep; this stock is brought from all parts of the country in cars, containing, on an average, 20 cattle, 70 hogs, or 100 sheep. The business of the yards is to receive the stock and take charge of it until it changes hands, an operation which is very rapidly performed, and occupies about a thousand men employed by the Stockyard Company; a similar number in the service of 120 commission merchants, and about 300 buyers. As soon as the animals have been sorted, classified, and weighed, which latter operation is performed in fifty-ton scales, they are turned over to the buyers, who distribute them to their destination—the slaughterhouses. Here the work is minutely subdivided, and the rapidity with which the practised hands perform their work is astonishing; almost every part of the animal is utilised for some purpose or another, and the carcasses, after having been properly prepared, are taken upon tramways into the refrigerating rooms, where they are kept at a temperature of about 36 deg. From here they are taken on to the train-loading platforms, cut into quarters and placed in the refrigerator cars, whence they are distributed all over the country or shipped for export. There are a number of so-called packing companies in Chicago, the largest of them being that of Armour and Co. During the year 1890 this firm did a business amounting to £15,000,000 sterling; they killed 1,500,000 hogs, 650,000 cattle, and 350,000 sheep; they employed 7,000 workmen; they keep 1,800 refrigerator cars in constant service, and the floor area of their factory is 180 acres, with a storage capacity of 130,000 tons. A branch works of this company utilises the refuse from the slaughterhouses; last year they manufactured 6,250,000 pounds of glue and 9,000 tons of fertilisers and grease. The champion slaughterman of Messrs. Armour and Co. kills 5,000 hogs every day; but the greatest celebrity at this establishment is a steer, whose occupation is thus described by a Chicago writer: "He is perhaps the most depraved animal in existence. There is no element of brotherly love or patriotism in his nature. His duty at the yard is to guide droves of cattle to the slaughterhouses. He has mastered his little act, and reduced steering steers to a science. Every day he takes his post near one of Armour's packing-houses and waits until it is necessary to drive a herd of cattle up the viaduct to the killing-rooms. He then joins the drove, ingratiates himself into their goodwill, and tells them that he knows of a good pasture not far away. At his suggestion the cattle think about it, and finally resolve to let him lead them there. Bill, the Bunko steer, laughs softly, and a cruel look lights his eyes. He lopes off through the mud towards a large gate not far away. Following him are a hundred or more cattle, every one entertainining a vision of gently swelling hills covered with long wavy blue-grass and sweet clover blossoms. Bill leads

them to this gate, and allows the herd to go through it, while he steps aside and avoids the rush. As the dust of the rush clears off a little, a familiar figure is observed slowly strolling away from the gate. It is Bill; on his face is no remorse as he saunters back to his post of duty near a tall fence. He is then ready to betray a couple hundred more of his unsuspecting relatives."

Last year, a new stockyard company was organised at a greater distance from Chicago, and an area of 2,000 acres of land has been set aside for this purpose; at present, however these stockyards are not in operation.

After the packing and slaughtering industry, comes the grain trade of Chicago. From the agricultural regions of the Middle and Western States the grain is brought by train or by lake to Chicago, where it is stored in elevators for distribution all over the country. There are twenty-seven grain elevators in the city with a total storage capacity of about 29,000,000 bushels; the largest of these great warehouses, belonging to the Armour Elevator Company, contains 2,000,000 bushels; the average capacity of the others range from 1,000,000 to 1,500,000 bushels. The shipment of cereals from Chicago during 1890 were in round figures 12,000,000 bushels of wheat, 90,000,000 bushels of corn, 71,000,000 bushels of oats, and 12,000,000 bushels of rye and barley. About 8,000,000 bushels of this total were distributed by lake shipments, and this trade occupied no small portion of the vessels entering and leaving the harbour, and the total tonnage of which was 8,750,000, the number of vessels engaged in this trade being about 9,000. As all this very extensive shipping business is concentrated on the Chicago river and its branches, some idea may be gathered of the constant movement up and down the stream, and of the perpetual opening and closing of the bridges to the great hindrance of the street traffic. The river banks are lined with wharves, of which there are not less than forty-one miles. It is very evident that if this branch of carrying trade increases in the future, as it probably will, additional accommodation will be required, and by some means the lake front will have to be utilised for loading and unloading vessels.

I have attempted to give only a few general particulars of some of the principal industries and conspicuous characteristics of the City of Chicago. To enter into detail would carry this paper far beyond its proper limits, and would still fail in conveying accurate impression. No description, in fact, would do justice to this city of 1,200,000 inhabitants, almost every one of whom appears endowed with preternatural activity; which owns a street eighteen miles in length, almost a dead level for the whole distance, and on which are houses twenty storeys high; whose traffic is as noisy as it is ceaseless, both on the smooth running roped-worked railways and the ill-paved, jolting roads; where the roar of the locomotive and the scream of the lake steamer emphasize the fact that repose and silence are unknown, even in the dead of night; where a pall of smoke, the outpouring of a thousand factories and of ten thousand dwellings, reminds the Englishman of home. Picture all these things, and you can form some idea of Chicago, which has been raised in sixty years, by the indomitable energy of Americans, to the rank of the sixth city of the world in point of population.

Extend the city along a frontage of 22 miles upon the shore of Lake Michigan; imagine parks and waste land; factories, fine buildings and hovels, spreading over this extended front; add six miles of railway skirting the lake shore in the busiest part of the town, and remember that this vast succession of streets and houses is built upon the shore of a tideless sea, alive with ships, now sailing over waters as smooth and bright of hue as those of the Mediterranean; now fighting their way to or from port, in storms more sudden and severe than the Mediterranean ever knows.

Great as Chicago is, the period of her true greatness has yet to come. Its commencement will dawn when her inhabitants give themselves leisure to realise that the object of life is not that of incessant struggle; that the race is not always to the swift, but rather to those who understand the luxury and advantage of repose as well as of sustained effort. Real greatness does not depend on length of streets, nor height of houses, nor even on colossal fortunes; but rather on the wise application and equally wise conservation of energy and intellect. When Chicago ceases to be the city of Perpetual Haste, and adopts the pace which will be inevitably set for her by time, the names of her great workers will not be erased so early from the book of life, but will be preserved to give their beloved city many more years of really useful work. At present, I think there are no old men in Chicago, because they have no time to grow old; and giving themselves insufficient time for leisure, they have, as a necessary consequence, little opportunity for the higher culture which is born of leisure. Of course I am speaking of the general rule, to

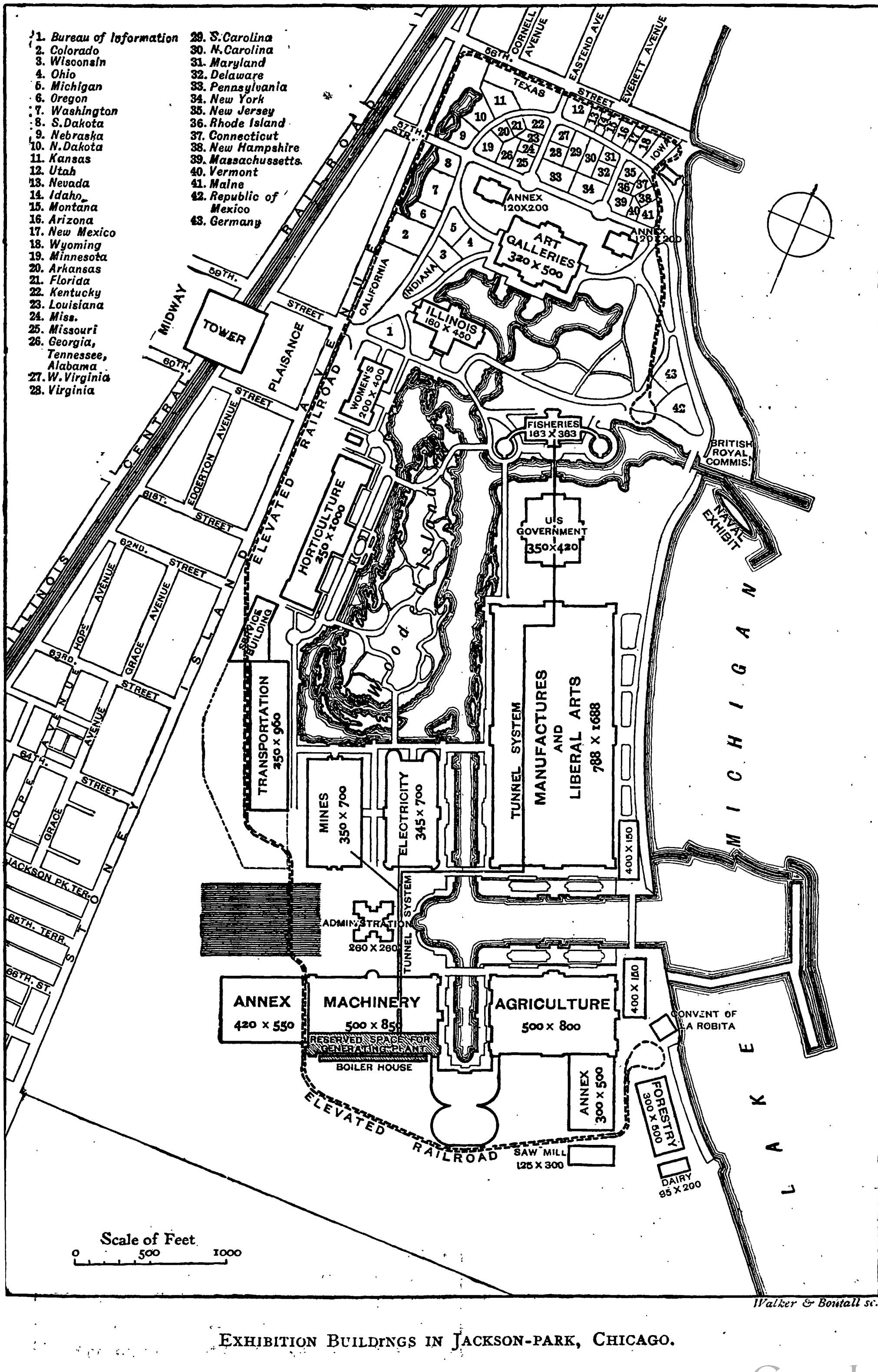
which there are many brilliant exceptions. It is probable that the Columbian Exhibition of 1893 will be the birth-place of this new phase of greatness of Chicago, for it will be full of every possible object-lesson, and will bring home to the inhabitants of the city, more forcibly than any other event could do, the fact that there is more in heaven and earth than had been dreamed of in their philosophy.

III.—General Plan of the Exhibition.

The site of the World's Columbian Exposition is about seven miles from the centre of Chicago; at first sight this comparatively large distance will appear objectionable, but no trouble will be caused to visitors, because the means provided for transportation, by trains, street railroads, and passenger steamers, will be amply sufficient to deal with the vast traffic expected. The site is really an ideal one, and of sufficient extent to satisfy even the most ambitious citizen of Chicago. It comprises Jackson-park, occupying 586 acres; Washington-park, a mile away, of 371 acres, and a strip of land called the Midway Plaisance, connecting the two, and contributing a further area of 80 acres. Thus there is a total of 1,037 acres available for the purposes of the Exhibition. Of this it is intended only to utilise Jackson-park and the Midway Plaisance for the buildings and grounds. Jackson-park is situated on the lake shore seven miles south-east of the city hall. Only a small portion of the northern part of this park had been laid out by the city prior to its acquisition by the executive; all the remainder was waste and marshy land, which has had to be reclaimed and adapted to receive the buildings. The large plan upon the wall shows the form of the park, the general disposition of the principal buildings, and their relative positions with regard to the lake shore. All that is most grandiose in the design, and most striking in architectural display, is concentrated near the south of the park on each side of a Grand Avenue terminating, on the one hand at the lake, and on the other with the Administration Building. A huge pier with a long **T**-shaped head, protected outside and to the north by breakwaters, encloses a harbour of sufficient extent to shelter all the smaller craft to be collected either for exhibition, or for the purpose of plying for hire. For the whole length of the Grand Avenue extends a broad basin with terraced slopes; in the basin the principal fountain display will be concentrated, and from it will be supplied the system of canals that runs throughout the grounds and expands into the lagoon situated in the centre of the park.

Although the façades of the various buildings facing the Grand Avenue are, each of them, the work of a different architect, the designs were prepared under such conditions as to secure a harmonious effect. Greater latitude in design was permitted in those structures which—more or less isolated—are not required to assist in aiding the effect of the principal perspective. The purposes of the various structures are marked upon the plan; to the south of the Grand Avenue are the Agricultural Buildings, with their stock-yards and annexes; a Forestry Building, and the Machinery Hall with its annexe, the former being connected with the Agricultural Building by a great classic colonnade. At the head of the Grand Avenue is placed the Administration Building, and on the north are the buildings for Manufactures and Liberal Arts, for Electricity, and for Mines and Mining. Westward and a little to the north is the Transportation Building; northward again, and facing the lagoon with the wooded island in the midst, is the vast Conservatory devoted to Horticulture and to Floriculture. North of this are the Women's Building, the Pavilion of the States of Illinois, and the Art Galleries with their annexes. The remainder of the park at this end, which is the area that had already been reclaimed by the Park Commissioners, is reserved for the pavilions of the various States, each one of which it is hoped will be represented. Returning southward by the lake shore, we come to a large space that has been set aside for the official pavilions of foreign countries, and here I may mention that the Exhibition Executive had reserved for this country the most advantageous site of all, the point of land facing the lake, and immediately to the north of the American Government Naval exhibit, about which I shall have more to say presently. North of the canal connecting the lagoon with the lake is the Fisheries Building; and south of this canal, extending to the north end of the Industrial Building, is a large area set aside for the United States Government, and on which their building will be erected. After this we arrive at the Great Hall of Manufactures and Industrial Arts, from which we started.

From the foregoing brief review it will be realised that the Exhibition comprises a large number of very important structures; of these I have only enumerated the most im



EXHIBITION BUILDINGS IN JACKSON-PARK, CHICAGO.

portant, but in the following list all the buildings to be constructed by the executive are set forth in detail, together with their dimensions, acreage, and estimated cost:—

Buildings.	Feet.		Feet.	Acres.	£
Mines and Mining ..	350	by	700	5·6	52,000
Liberal Arts	787	by	1687	30·5	200,000
Horticulture	250	by	1000	5·8	60,000
Electricity	345	by	700	5·5	73,000
Women's	200	by	400	1·8	24,000
Transportation	250	by	960	5·5	56,000
Administration	260	by	260	1·6	90,000
Fisheries	163	by	363	1·04	
Annexes	135	diam.		0·8	40,000
Agriculture	500	by	800	9·2	
Annexe	328	by	500	3·8	108,000
Assembly Hall	450	by	500	5·2	40,000
Machinery	500	by	800	9·8	
Annex	490	by	551	6·2	240,000
Power House	80	by	600	1·1	
Fine Arts	320	by	500	3·7	
Annexes	123	by	200	1·1	100,000
Forestry	200	by	500	2·3	20,000
Sawmill	125	by	300	0·9	7,000
Dairy	95	by	200	0·5	6,000
Live Stock	53	by	330	1·3	
Live Stock Sheds ..				40·0	30,000
Casino	175	by	300	1·2	30,000
Totals				144·8	1,176,000

In addition to the foregoing, there is the United States Government Pavilion, 350 feet by 420 feet, covering an area of 3·4 acres, and to cost £80,000; and the model battleship of the Navy Department, 348 feet long by 69·25 feet wide, and occupying ·2 acres in the lake; this exhibit will cost about £20,000. Finally, there is the Illinois State Building of 160 feet by 450 feet, or 1·7 acres, and which is to cost £50,000. It should be mentioned that the sum of £30,000 debited to the Casino (and which will probably be abandoned) in the above list includes the cost of the pier which has been already referred to. Of the principal buildings there will therefore be 150·1 acres, the estimated cost of which is £1,326,000. But besides these there will no doubt be several others, to say nothing of annexes; amongst them a large Music Pavilion and a Press Building are already being designed, and the very lowest estimate which the Grounds and Buildings Committee is justified in advancing is no less than £1,459,000. It is impossible to say at present how many State pavilions and buildings erected by foreign nations there will be in Jackson-park; the most moderate estimate places them at about eighty.

It will be interesting to compare the size of the Columbian Exhibition with that held in Paris in 1889. Leaving out Washington-park, which is at the disposal of the Executive, but which probably will not be used, Jackson-park and the Midway Pleasance make up altogether an acreage of 660. The Champ de Mars, the Trocadero, the Esplanade des Invalides, and the quays, were together 173 acres, so that including the harbour, which may be fairly reckoned as a part of the Exhibition grounds, the size of the World's Fair of 1893 will be four times as great as that of the Exhibition of 1889. We have seen that the principal buildings at Chicago will occupy a space of 150 acres; those of Paris covered 55 acres. Most of you will have a lively recollection of the fatigue inseparable from a thorough exploration of the Paris Exhibition, and you will therefore realise the necessity that will exist in Chicago for a complete system of passenger transit throughout the grounds; I believe that I may safely assure you the arrangements in this respect will be very ample and varied. I may now proceed to describe very briefly the leading characteristics of the principal buildings.

IV.—The Agricultural Building.

The Agricultural Building is of about the same dimensions as the adjacent Machinery Hall—500 feet by 800 feet—and covers an area of 9·2 acres. Its architecture is strictly classic, and harmonises well with the rest of the buildings facing on the Grand-Avenue. Its general cornice line is 65 feet above the ground level, and its chief features are large corner pavilions and central entrances connected all round by a lofty colonnade. In the centre of the building will be a rotunda 100 feet in diameter, and 130 feet high, and the exterior will be enriched by statuary placed at all the salient points. As at present designed, the interior of this building is not of a striking character, as it is divided into a large number of small galleries. I am given to understand, however, that this arrangement is not definite. Adjoining the Agricultural Building are several others: an annexe, 328 feet by 500 feet, to receive overflow exhibits; a sawmill, nearly an acre in extent; and a Forestry Building of 2½ acres.

The names of these buildings indicate their purpose, as also does that of a dairy, half an acre in extent, and in which it is intended that all the most advanced appliances and methods of American dairy farming shall be exhibited. South of the Agricultural Building are the

yards and sheds for live stock, the latter covering no less than 40 acres; while the whole space devoted to this section of the Exhibition will be at least 60 acres. There can be no doubt that, to the large majority of inhabitants of that vast district devoted to cattle raising, of which Chicago may be considered the metropolis, this section of the Exhibition will be of special importance. I am informed that the closest attention is paid—by those interested in this industry in America—to the cattle breeding of this country; and that the export of pedigree cattle in the United States is a very large one. If this be so, the stock-yard section should also be specially interesting to our own cattle raisers; and official assurance has been given that every possible facility to intending exhibitors in this section by the Transportation Committee. It should be remembered that pedigree stock is imported free into the United States. Messrs. McKim, Meade, and White, of New York, are the architects for this building and annexes.

V.—The Machinery Hall.

The Machinery Hall is 500 feet wide and 850 feet long; with its annexes it is to cover an area of about 17 acres. At one end and connected with it is an annexe 500 feet wide and 550 feet long. The position of this very important building is shown on the plan, where it will be seen that its principal façade faces on the Grand Avenue; it is this façade upon which the chief architectural detail is concentrated. Beyond it and at the head of the short canal branching from the basin, the façade of the Machinery Hall is connected with a colonnade that adds greatly to the imposing effect, and at the same time serves as a screen to separate the stock yards of the Exhibition from the rest of the grounds. This colonnade, which is of considerable extent, is carried as far as the Agricultural Hall, so that the visitors can pass from one to the other without being exposed to the weather. The general scheme of the main building of the Machinery Hall behind the ornamental exterior is rectangular, and the vast space is divided into three galleries, each about 130 feet span; there will, therefore, be no very extensive engineering work in this building. In the centre of the hall the three galleries just referred to will be crossed by a transept of about the same width, and the intersections are marked by the construction of three domes. At each corner is a large pavilion with a domed roof; entrances to the building will be provided in each of these pavilions, but the main portals will be on the north and east sides where the classic porticoes will be placed; these porticoes will be flanked by towers 200 feet in height. Between the corner pavilions and the central entrances on the north and east sides, the exterior will consist of open loggias or colonnades two stories in height and with internal galleries; these are covered by a flat roof. A similar flat roof covers the outer part of the building on the south and west sides, but as these sides will not be so much exposed, elaborate architectural effect is dispensed with. The building will be lighted by skylights over the flat roofs, and by raised lanterns at the top of the main arched galleries; the greater portion of the domes will also be glazed. Most of the framing of this building will be of steel, though all the skeleton of the exterior is of timber very cleverly arranged and covered with cement and "staff," in the same way as all the decorative effects of a similar nature are obtained throughout the Exhibition. The foundations, however, are of wood, designed on the same lines as those already referred to when I was speaking about the great buildings of the city. Only as the structures at Jackson-park are temporary, it was not considered necessary to incur the considerable cost of iron and concrete platforms, but precisely the same method of distributing the weights has been adopted except in those cases where the uncertain nature of the ground rendered piling a necessity. Extensive galleries will be erected around the interior of the building at the same height above the ground as the galleries of the loggias before mentioned; they will be reached by eight main staircases and a number of subsidiary ones, as well as by elevators. The annexe to the Machinery Hall will be built largely of wood, and will have no pretension to architectural elaboration. On the south side of the main building a boiler-house will be erected, 80 feet wide and 600 feet long. In this building will be generated all the steam required for the great power station that is to furnish the Exhibition and grounds with the necessary energy, calculated at present at 25,000 horse-power. The engines by which this force is to be generated will be placed together within the Machinery Hall, a sufficient area on the south side being reserved for that purpose. It is intended that both engines and boilers, with all the auxiliary machinery, should constitute exhibits, and as this is a point upon which some of our manufacturers will certainly feel considerable interest, I repro-

duce here the official information as to the terms on which steam-engine exhibits, intended to form a part of this power station, will be received. "Engines aggregating 25,000 indicated horse-power will be required. These must all be compound, either cross or tandem, horizontal or vertical, or triple-expansion. These engines may be of any automatic type, high or low speed, and must be condensing, manufacturers to furnish condensers. Steam pressures will be of 125 lb., 150 lb., and 200 lb. per square inch; either pressure may be used at the option of the exhibitor. The work to be done will be generating electricity either for arc or incandescent lighting, power transmission, or driving line shafting. No engine shall be of a smaller capacity than 150, nor of a greater than 1,000 horse-power. If it is desired to drive line shafting, engines should be of low speed and capable of working up to 325 horse-power, with an economical working load of 160 horse-power. For operating dynamos they may be of any type, and capable of developing from 150 to 1,000 horse-power. The basis on which engines will be accepted will be as follows:—Such engines are to be consigned by the manufacturers to the World's Columbian Exposition, and will be placed upon foundations free of all cost to the executive, which will prepare foundations of concrete, according to drawings furnished by the manufacturer, will make all steam and water connections, maintain, operate, and furnish all supplies, such as oil and waste, during the Exposition; the manufacturer to remove the engine at the end.

"The engines will remain the property of the exhibitor, and will be considered as exhibits in operation. Exhibitors will be required to furnish operating engineers, whose wages will be paid by the Executive, and who will be subject to the direction at all times of the Chief of Construction. Such manufacturers as decide to exhibit engines under the above conditions should make application without loss of time to their respective commissions."

This very large power station will be utilised not only for transmission of machinery in motion in the Machinery Hall, but for distributing current throughout the various buildings and grounds, for power, lighting, and other purposes. It should be mentioned in this place that it is the present intention of the Executive to introduce a complete novelty for driving machinery in motion. The great success that has attended the distribution of energy by compressed air on the Popp system in Paris, has encouraged the Executive to employ this means of operating the machinery in motion. The advantages attending this innovation will be very great; not only can cold air machines and refrigerating machinery be supplied direct, but the Machinery Hall will be kept cool—a very important consideration during the summer. Besides this all the many annoyances to exhibitors and visitors arising from leaking steam pipes and defective joints will be avoided; leakage will be an advantage instead of an inconvenience (except as regards loss of power), and a great complication in the mains beneath the flooring will be avoided.

If this project is put into execution, a large amount of air-compressing machinery will be required; this will be treated by the Executive much in the same manner as the engines already referred to above.

Returning to the power station, it will be realised that the greater part of the 25,000 horse-power will be required to drive electric current generators, which will also be exhibits. A very elaborate system of underground mains will be laid in tunnels constructed so as to reach all the buildings requiring light or power, and every part of the grounds. A circular electric elevated railway will be constructed so as to include the principal buildings, and as on this, very frequent trains will be run, a large amount of power will be consumed. Current will be delivered to all the separate buildings of States and foreign countries, and such power (of course with some exceptions) as will be required to show machinery in motion in various parts of the grounds will be furnished from the central station. It is the intention of the Executive, during the Exhibition, to subject —if the exhibitors approve—all the machinery employed in connection with the central station, to an elaborate and careful system of trials, so that the actual and relative efficiences may be ascertained.

The Electrical Department, the chief of which is Mr. F. Sargent, desires to give every possible encouragement to foreign electrical engineers and contractors, to induce them to compete for the contracts of laying mains, providing lamps, generators, motors, and other plant that may be required in carrying out the electrical system of the Exhibition, and also to tender for the maintenance of such work during the continuance of the Exhibition. Such competition would no doubt be of great interest to some of our own industrials, but I am informed that if such work were done as an ordinary contract, and not as an exhibit, the tariff regulations would make it difficult, if not im-

possible, for any foreign contractor to compete. If, therefore, the Exposition authorities desire such foreign co-operation seriously, it rests with them to meet these difficulties so as to place foreign manufacturers on equal terms with those of the United States.

The space reserved for Great Britain and her colonies in the Machinery Hall is 40,000 square feet, about the same space which she occupied at the Centennial Exposition of 1876. Whether under the existing conditions of trade and competition with the United States it will be possible for us to occupy this large area, it is too early to predict; it must be borne in mind that any machinery shown in the Transportation, Electricity, or Mines Buildings will be placed there at the expense of Machinery Hall. Still, I think that there are sufficient manufacturing engineers in this country whose interests in the United States—either actual or prospective—or with other countries, are important enough to induce them to make a fair, though perhaps not a representative, display. The architectural work of the Machinery Hall is by Messrs. Peabody and Stearns, of Boston.

VI.—The Administration Building.

The Executive of the World's Columbian Exposition have determined that the most elaborate structure to be erected on Jackson-park shall be that devoted to administrative purposes. The determination is commendable for several reasons. In the first place the idea is novel, and well chosen novelty on the heroic scale is most desirable in international exhibition design. The Paris Exhibition of 1889 will long be remembered by many millions, chiefly on account of the Eiffel Tower; the popular souvenir of the Columbian Exposition of 1893 will undoubtedly be its Administration Building. Occupying a superb site, the most conspicuous upon the grounds, it will prove a triumphant answer to those prejudiced and Transatlantic critics who have persistently declared that nothing good can come out of Chicago. It is true that New York may claim the credit of the design, for with broad-minded policy, the Executive had recourse to the architect they considered best able to carry out the conception, regardless of possible local opposition. But the idea belongs to Chicago, and the money by which it will be carried out is furnished by Chicago.

Approaching in dimensions, and, in some opinions, surpassing in architectural beauty the Capitol at Washington, the Administration Building will form a fitting monument to the energy of the city to whom the responsibility of holding the celebration was intrusted. And in this probably lies the peculiar fitness of erecting this building, that it may serve as an unmistakable proof of the appreciation by Chicago of the honour rendered to her by the nation, and enable her to receive the representatives from all parts of the United States (as well as from all parts of the world) in a palace such as has never been before seen at any exhibition. The pity is, that so great an expenditure having been incurred in giving form to the ideas of the architect, it should be useful for only a few months, and that it should partake of the transitory character of all other buildings upon Jackson-park.

The Administration Building will be placed at the western end of the Grand Avenue. It is rectangular in plan, and the main façade faces eastward. The building measures 260 feet 6 inches on each side. The lower portion, which serves as a base for the dome, is made up of four pavilions, each four stories in height, and separated from one another on each side by the great entrances.

The roof of these pavilions is flat, and all four are connected by exterior galleries, forming together an extensive promenade for visitors. The pavilions measure 84 feet on a side, leaving a space of 92 feet between, the centre of which is occupied by a round-headed gateway, The entrances to the pavilions are within the rotunda, arranged symmetrically around the circular space beneath the dome. The same entrances give access to the stairways leading to the promenades around the dome. Separate staircases are, of course, provided for the different offices. These stairways are approached by a hall or vestibule 30 feet square. In each vestibule are two large elevators, that will not only serve the offices, but will convey visitors to the promenade above, and to the higher gallery running around the springing of the dome. The pavilion will contain the offices of the President of the United States Commission and those of the Director-General: the fire and police departments, and the offices of the secretary and clerks of the Executive Board, the offices of Public Comfort, the Bureau of Publicity, and a restaurant, the Ambulance Department, the Foreign Department, Information, &c. Besides this, there will be committee-rooms and board-rooms, a bank, and all the various accommodation required for administrative

purposes. Although these pavilions are divided into four storeys, no such arrangement is indicated on the exterior of the building, which is designed in one scheme of Doric architecture, to form a base or plinth surmounted by a massive balustrade, the piers at each angle being crowned with sculpture. The great doorway is also flanked with sculpture, and statues about 14 feet in height crown the piers on each side of the entrances, between them being panels bearing appropriate inscriptions. The second stage of the building that constitutes the actual base of the dome is about 70 feet in height and octagonal in plan; it carries up the central portion of the building from the ground floor. The architecture is Ionic, and the chief feature is a pavilion at each corner surmounted by a small dome, and with groups of statuary over every pier. These pavilions are connected, on the four sides, with an open colonnade 20 feet in width and 40 feet high; the columns will be four feet in diameter; this colonnade will serve as a public covered promenade. From this stage rises the dome, at first—for a height of 30 feet—with vertical sides and octagonal in shape. This part is divided into panels, three on each face, the panels being filled with medallions bearing famous names. Above the mouldings over these panels is a second set of panels, enriched with garlands, and at each angle of the octagon with sculptured eagles. From this level the dome, 120 feet in diameter, curves till it reaches a height of 264 feet from the ground, the distance between the heavily moulded ribs corresponding to that between the styles beneath. The spaces between these ribs, nearly to the top of the dome, are to be filled in with burnished metal, and the dome is surmounted with a skylight. Gilding and rich colour will be lavished on this part of the building to emphasize the effect sought to be produced, that the Administration Building is the central and most important part of the Exhibition, although of itself it contains no exhibit, and constitutes one only in the sense that it will show how far the science of architecture has developed in 1893. The architect of this splendid building is Mr. Richard M. Hunt, New York, President of the American Institute of Architects.

VII.—The Liberal Arts Building.

The Liberal Arts Building, with an area of 30½ acres, will be essentially the monumental palace of the Exhibition. Its architectural features, especially those of the south façade facing on the Grand Avenue, are very elaborate; this part of the work was designed by Mr. George B. Post, of New York. The main entrance will be at the southern end, but there will be great portals on each side midway of the length, and a colonnade runs around the building. Originally it was intended that a series of comparatively narrow roofs within the external architectural decoration, should inclose on all sides a great inner court broken in the centre by a dome 370 feet in diameter. It was, however, soon realised that the space occupied by these inner courts could not be spared, and the whole area will now be roofed in by a single span 368 feet wide and 208 feet in height, the narrow surrounding galleries being retained as in the original design. The great span is the same as that of the Machinery Hall at the Paris Exhibition of 1889; it is, however, 61 feet higher, and the building is of considerably greater length. It has been designed by Mr. Shankland, one of the chief engineers in Mr. Burnham's department. It may be interesting to mention that the entire width of the Exhibition of 1851 was less than that of this building, and its maximum height was only half as great. The side galleries, which inclose the great central gallery are three in number on each side, and respectively 52 feet 3 inches, 107 feet 9 inches, and 46 feet in width; the clear height of the largest of these spans will be 97 feet. An upper gallery, 25 feet above the ground, will be constructed throughout the whole length of the smaller spans, so that a large additional amount of floor space will be available. Between the great girders of the central roof, galleries will also be placed, 25 feet above the ground, and projecting into the hall, from which visitors may obtain a good view of the Great Gallery and its varied contents from a commanding position. It is in this building that the largest and most important space, amounting to 120,000 square feet, has been allotted to Great Britain and her principal colonies. The greatest liberality has been shown by the Exposition Executive with regard to the arrangement of exhibits by foreign nations within their respective sections. It was the intention of the classification committee that all objects exhibited should be arranged according to their character and not by nationalities; but this obviously inconvenient arrangement has been set aside, and Great Britain will be at liberty to arrange all her industrial exhibits within her own section, following of course the general classification that has been laid down. If, therefore, it

should unfortunately happen that the co-operation of this country is not so extensive as we hope, we shall be represented in only three or four groups—chiefly those relating to Industries, the Fine Arts, and Machinery. At the same time space has been reserved for us in all of the principal buildings, so that, if necessary, British exhibits will be distributed throughout the main buildings, always, however, being grouped within the space allotted, so as to make a number of important groups.

The classification of exhibits within the Manufactures and Liberal Arts Building is so wide and varied that it must include a number of objects which are specialities in this country, and which may be shown greatly to the profit of manufacturers even as regards sales in the United States. Furniture, glass and china, art metal work, tissues of various kinds, travelling equipments to a limited extent, hardware, and cutlery, and in short all the large class of goods which Americans purchase in this country should meet with a large demand.

A passing reference may be made to a strictly non-commercial class of exhibits which will be collected in this building, that relating to ethnology and anthropology; this section will be under the charge of Professor Putnam, and it is to be hoped that the valuable collection which he is making will be supplemented by large contributions from Europe. A detailed reference is made to it later.

VIII.—The Electricity Building.

The Electricity Building covers an area of 250,000 square feet, and is estimated to cost 130,000 dols. The architects are Messrs. Van Blunt and Howe, of Kansas City, and the design appears not only admirably adapted for its purpose, but sufficiently well proportioned and ornamental to take a front rank among the many splendid buildings on Jackson-park. The main entrance to the building faces on the great central avenue, near the Administration Building. The principal architectural feature at this end of the building is a portico and colonnade extending for the whole width on each side of the monumental entrance, over which are inscribed a series of names famous in the annals of electrical science. The main tower at this end reaches an elevation of about 200 feet, those at the sides being somewhat shorter and of more slender proportion. Except for the two large bays at the back of the building, the plan is rectangular, the length being 690 feet, and the width 345 feet. The centre of the building is occupied by a large hall, running from end to end, and about 115 feet span, flanked by a double row of columns and aisles 70 feet in width. Important entrances will occupy the centre of the building on each side, and access is gained to the galleries by broad stairways occupying the middle of the building. The end bays will be glazed so as to afford as much light as possible. Large as are the dimensions of this building, it may be confidently expected that they will be insufficient to accommodate the exhibit. Electricity and its practical applications will be one of the largest and most important sections of the Exhibition, and during the next two years there will, doubtless, be many new developments not yet brought into a practical form. In connection with this building, some general particulars of the scheme of electric lighting at Jackson-park may be given. The plans have been elaborated by the chief electrical engineer, Mr. Sergeant, and his proposals have been accepted by the committees on electricity, on the grounds and buildings; and by Mr. Burnham, the chief of construction. As upon every other point, so in this matter of illuminations, the Executive appear determined to surpass all that has been hitherto attempted in this direction at international exhibitions. In 1889 only three of the main buildings were opened at night to the public and furnished with electric light. It has now been decided that complete arrangements shall be made for lighting every one of the great halls at Jackson-park as well as the extensive grounds. The scheme elaborated up to date refers to nine of the great buildings, and comprises 5,180 arc lamps of 2,000 candle-power each, and 14,700 incandescent lamps of 16 candles. Except in the Fine Arts, the Administration, and the Women's Buildings, arc lights will be employed and will be distributed as follows:—In the Machinery Hall there will be 600; in the Agricultural Hall, 600; in the Electric Building, 400; in the Mines and Mining Building, 400; in the Transportation Building, 450; in the Horticultural Hall, 400; in the Forestry Building, 150; and in the Industrial Arts Building, 2,000. As just stated, there will be no arc lights employed in the Fine Arts Buildings, but in their place the interior will be lighted by 12,000 incandescent lamps. The Administration Building will be illuminated in the same manner, and about 10,000 sixteen-candle lamps will be required for this purpose. The lighting of the Women's Building will be

mixed, and comprise 180 arc lamps and 2,700 incandescent lamps. In addition to the lighting supplied by the authorities, any exhibitor who requires it will be able to obtain current for lighting his display, in any manner he thinks fit, conformably with the lighting regulations. It is presumed that this current will be furnished to private consumers at a fixed and very moderate tariff. The arrangements for lighting the grounds, for the illuminated fountains, for private lighting, and miscellaneous purposes, have not yet been completed. It is decided in principle, however, that every one of the numerous pavilions and official buildings will be abundantly supplied with electricity, so that any reasonable amount of light can be obtained, and gas will be practically, if not actually, unknown at Jackson-park as an illuminant. It is intended, amongst other novel applications of the electric light, to illuminate the harbour inclosed within the pier and breakwater, already referred to, either wholly or in part, with submerged incandescent lamps so arranged that the light may be thrown upwards towards the surface of the water. Such an arrangement would undoubtedly consume a large amount of power, but the effect would be very striking and attractive.

It should be mentioned that already a large amount of electric power is available on the grounds, an extensive installation having been completed and put in operation. It has been ordered by the Executive that the contractors are not to be allowed to use steam power, but that they must work all their machinery by electricity; this has been done to reduce the risk of fire during the progress of the work. All the sawmills set up for the Industrial Building are driven by this means, and the contractors for the Administration and Horticultural Buildings are already using a considerable amount of the same power. There are at the present time at least a dozen motors driven by current furnished from the temporary central station. This is an entirely novel application of electricity in connection with exhibition buildings.

A very considerable amount of current will also be required for lighting the grounds through the long winter nights, during which work will be carried on continuously by different shifts of men. The arrangements made between the Executive and the directors of the labour unions, limit the length of daily work to eight hours. By this means the Executive is confident that they will carry the work forward to its conclusion, without any interruption due to labour troubles.

IX.—Mines and Mining Building.

The Mines and Mining Building, which adjoins the Electricity Building on the north side of the Grand Avenue, covers an area of 5·6 acres. Its architecture harmonises with the rest of the principal structures. It presents a suggestion of early Italian Rennaissance, treated somewhat liberally by the American architect. The main entrances, of which there are four—one in the centre of each side—are richly embellished with sculpture, symbolical of the uses to which the building is to be employed. A large square pavilion surrounded by a low dome, marks each corner of the building, and between the pavilions and the several entrances are richly decorated arcades, projecting beyond the outer walls, so as to form a loggia on the ground floor, and a wide gallery 25 feet above. These covered galleries are 25 feet wide, and are each of them 230 feet long; access to them will be obtained by various smaller entrances. It may be mentioned that the effect of this part of the building will be extremely rich, as marble facings will be used throughout in great variety. This marble will constitute exhibits, and will have a marketable value at the end of the Exhibition. The arched ceilings of the loggia will be heavily moulded in plaster, and will be highly coloured, to conform with the general scheme. The fronts of the building are 65 feet in height to the top of the cornice, while the main central entrances reach a height of 90 feet. The same scheme of treatment, though carried out in a somewhat similar manner, is applied to the longer sides of the structure. In plan the Mines Building is rectangular; it will comprise a main hall 115 feet wide and nearly 100 feet in height; on each side will be an aisle 57 feet 6 inches wide and 50 feet high. The whole of this will be constructed in steel in a bold and somewhat novel manner. Around the main hall runs a wooden structure 60 feet in width and 60 feet high; a gallery, the height of which corresponds with that of the gallery over the loggia, will run around all four sides of the building, thus inclosing the main hall. Access to the galleries may be obtained by broad stairways placed on each side of the entrances. This building, which, as has already been said, presents some striking originality, was designed by Mr. S. S. Beman, of Chicago; its estimated cost is £52,000. There

can be no doubt that the contents of this building, so far as the United States exhibits are concerned, will be of the highest possible interest. Within it will be grouped all varieties of raw mineral products; of metals obtained from the ores; manufactured metals; mining and metallurgical machinery; everything, in short, that will serve to illustrate the vast industries of mining and of metallurgy. The United States is so rich in natural mineral resources of almost every kind, and its requirements are so large and varied, that the mining and metallurgical industries have been developed to a remarkably high degree. More than this, as the natures of similar ores differ widely in various parts of the country, and as the conditions under which they can be obtained and converted differ almost as widely, it follows that a great range of processes have been developed in America, or adapted from Europe, and that if these are fairly represented at Chicago, the most advanced practice of the mining engineer will be fully illustrated. Probably we may not have much to display with advantage in this building; in some respects American practice is of necessity far in advance of our own; in others, commercial reasons suggest the prudence of not exhibiting those of which this country makes a speciality. There is, however, one point to which I should like to direct special attention. One of the most interesting exhibits in this building will be a large series of collections of ores and minerals systematically arranged. Almost every metalliferous State in the Union possesses complete and carefully arranged collections of this nature, and these combined will illustrate the mineral resource of the country. It is earnestly desired by the chief of this department to add similar collections from different parts of the world, which would be carefully guarded, and every possible assistance guaranteed to the lenders.

According to the general scheme of the Columbian Exposition, and under the classification provided for the installation, many branches of the mining industry, heretofore incorporated in other departments, will be placed in their legitimate positions in the Mining Building, so that, when the exhibits shall have been properly collected, classified, and arranged, the department will be a comprehensive and complete exposition of all the great mineral treasures of the earth, and the methods employed in their search, treatment, and use.

An inspection of the classification of Department "E"—Mines and Mining—gives some idea of the variety of exhibits included. The raw materials and the natural products to be exhibited in the Mining Department will constitute the basis of every other exhibit made, except those of Agriculture and Horticulture. The groundwork of all the arts, sciences, and mechanical industries will be comprised within the walls of the structure dedicated to Mines, Mining, and Metallurgy. All of the precious minerals, and minerals, precious stones, mineral fuel, building stones and marbles, clays and sands, salts and pigments, as well as the machinery, implements, and appliances employed in their conversion to use, will be fully represented.

The subject of coal will be treated on very broad lines. It would be impossible to accept for exhibition purposes all the really meritorious specimens that can be secured in the United States for the purpose of demonstrating the coal resources of that country. The treatment will be comprehensive, and the display based upon the distribution of the great coal-fields that are so conspicuous in the geology of the United States. The industry is of gigantic proportions, involving the investment of many millions sterling, and the employment of hundreds of thousands of people. The display of coal at the Exposition will be qualitative rather than quantitative. The different varieties, produced at different localities, will be shown, together with the chemical analysis of each, and the results of tests determining their economic value and adaptability to various purposes. The coal resources of the different States will be shown by geological maps and drawings exhibiting the stratification, &c., which will render apparent the extent and accessibility of the vast number of coal beds and veins which underlie the entire Continent.

As regards iron, efforts will be made to have an adequate exhibit of that great branch of industry. Without considering the contributions that will be made to this division by foreign Governments, the United States, which is now the first nation in the world in iron production, will provide a display of the greatest interest and benefit to the manufacturing world. The development of the iron resources of the Southern States within the past few years, no less than the attention which has been devoted to this particular industry in the west during the same period, gives a leading interest to this product. It is intended to arrange the exhibit with the fullest apprecia-

tion of the magnitude and importance of the iron industry, with ample data as to the location and extent of the greater deposits, the analyses of the ores, and statistics, not only based upon the operations of the past, but in a degree indicating the extent to which they may be carried on in the future.

Every provision has been made for the installation of the ores of the precious metals and cabinets of specimens contributed by private individuals, associations, and technical and mining schools. These will be arranged with minute care as to detail. States, individuals, collectors, and colleges in the United States will undoubtedly vie with one another in their endeavour to establish the superiority of their respective collections, or to demonstrate the value of certain mineral districts or areas. Many ingenious devices and designs will be utilised by the several States, Territories, and countries to illustrate the magnitude of their auriferous and argentiferous deposits.

The mechanical appliances of mining pans, cradles, and rockers, modern and complicated amalgamating, concentrating, and smelting machinery. Crushers, centrifugal quartz mills, stamps, rolls, jigs, frue vanners, concentrators, roasting and melting furnaces, reverberatory and matte furnaces, bullion cars and pots, crucibles and ladles—in short, the entire plant of milling, smelting, and refining works of different descriptions will be shown. It is intended to demonstrate the process of extracting precious metals in the most thorough manner. Gold and silver bearing rock will be passed through the various stages until the pure metal is exposed. The mining machinery manufacturer will be given ample opportunity to display the excellencies and demonstrate the usefulness and economy of his machines.

Plans for, and the best methods of, equipping assay offices will be presented and illustrated. Melting and scorification furnaces, with muffles, cupels, &c., with melting pots and fluxes handy for the production of the assayer's "button," volumetric and other test methods, rolls, and small crushers for preparing test lots of ores, the most delicate instruments of precision—these and the associated appliances of metallurgy will be exposed.

Marbles, agates, jaspers, onyx, silicified wood, &c., will be collected. Numerous machines and tools for channelling, sawing, lifting, turning, and polishing granites, sandstone, marble, &c., will be arranged for the purpose of demonstrating the facility with which great masses of stone are transformed into useful and ornamental objects and made suitable for the most skilled handicraft.

Sands for the manufacture of glass, many coloured clays, and kaolin of all grades for the potter, brickmaker. porcelain worker, &c., polishing substances, whetstones, hones, and emeries, will be included, Asphalte and cement mixtures and artificial stones which are adapted for road-making will be illustrated in all the multifarious uses.

Adding to the colour, effect, and interest of the exhibit, will be variegated heaps of nitrates, sulphates, borates, pigments of all kinds, ochres and vermilions, phosphates, coprolites, and every variety of mineral fertilisers. In another group graphite, with the methods by which it is transformed for use in the shape of lead pencils, crayons, lubricants, &c., will be exposed.

Ingots, bars, and castings of white aluminium, with aluminium alloys, will be found in juxtaposition with pigs and bars of copper. Tin ores and block tin, sheet and bar zinc, ingots of nickel, specimens of bismuth, antimony, arsenic, and other minerals with their ores and alloys, will be systematically arranged.

In the Mining Machinery Section will be shown every species of apparatus, simple and complex, employed in working a mine from the lowest level to the dump. Methods of timbering, ventilating, and lighting the various slopes, levels, and galleries will be shown by examples. Trams, hoists, and automatic dumps, engines for pumping, rock breakers, screens, grizzlies, and other sizing appliances will be shown. Improved diamond drills, and contrivances for loading and unloading coal and ores, and for their storage; automatic stevedores for transference on the surface; patent self-emptying cars; wire ropeways with their outfits of buckets, &c., coal tips, steam shovels, belt conveyors, &c., will complete the methods by which the mining operations of the present age are conducted.

For the purpose of practical study, the historical division of mining and metallurgy will be provided. The literature, maps, models, &c., of the leading educational institutions of the United States will present to the student in this department, at the Columbian Exposition, an opportunity of reviewing the entire subject of historical and statistical mining. Mining engineering will be adequately represented by surveys and plottings, by projections of underground work and models, and by literature descriptive of the methods of running

shafts, tunnels, construction of mine workings and the handling of ores.

X.—The Transportation Building.

The Transportation Building, designed by Messrs. Adler and Sullivan, of Chicago, is one of the group in the northern part of the grounds. It is simple in architectural treatment, although it is intended to make the detail rich and elaborate. The style is somewhat Romanesque, and the good proportions, and subtle relations of the several parts to each other, suggest the methods of composition followed at the Ecole des Beaux Arts. Viewed from the lagoon, the cupola of the Transportation Building will form an effective feature south-west of the quadrangle, while from the cupola itself, a fine beautiful effect of the entire Exposition will be seen. The main entrance will consist of an immense single arch enriched with bas reliefs and mural paintings; the entire feature will form a rich and beautiful yet quiet colour climax, for it will be treated entirely in gold leaf, and will be called the golden door. The remainder of the architectural composition falls into a just relation of contrast with the highly wrought entrance, and is quiet, though very broad in treatment. It consists of a continuous arcade with subordinated colonnade and entablature. Numerous minor entrances are pierced in the walls, and with them are grouped terraces, seats, drinking fountains, and statues. The interior of the building is treated much after the manner of a Roman basilica, with broad nave and aisles. The roof is in three divisions; the middle one rising much higher than the others, and its walls are pierced to form a beautiful arcade clerestory. The cupola, placed exactly in the centre of the building, and rising 165 feet above the ground, will be reached by eight elevators, which will form a part of the Transportation Exhibit, and at the same time be used for the conveyance of visitors. The main building will have a length of 960 feet, and be 256 feet deep; in addition to this, there will be a series of annexes of one storey buildings about 60 feet wide. A complete system of railway tracks will be made in and about these buildings, and a transfer railway with tables 75 feet long, will run the entire length of the structure for the purpose of handling the heavier class of exhibits. It is intended that almost every object which will illustrate the work of transportation will be grouped within this building. The contents will naturally divide themselves into means of transportation by land and water, with an interesting, but less important, section devoted to aërostatics. It is desired to give to the collection a historic as well as a practical interest, and, for this purpose, examples of the earliest and crudest forms of transportation appliances are being sought for in all parts of the world. Marine transportation will have, of necessity, to be illustrated chiefly by models; and it is hoped that this country, which is so rich in this class of objects, will be induced to contribute largely. The wealth of ship models recently collected at the Naval Exhibition showed how easy it would be for England to add a supreme interest to the Marine Section of the Transportation Building, and how incomplete the exhibit will be without such co-operation. The English manufacturers of bicycles and tricycles will probably find it highly profitable to exhibit in this section, since the demand for these means of locomotion in the United States is very great, and is constantly increasing, while the reputation of our own makers is far ahead of that of any foreign manufacturers. Locomotives, rolling stock, and railway material, could, it would seem at first sight, not be exhibited with any view to commercial benefit, but, considering the crowds of American visitors who come to England every year, it is not impossible that the interest and curiosity excited by the exhibition of standard English trains would divert the flow of travel to the lines of those companies which had been sufficiently enterprising to make such a display. If this should be done, it would be advisable for railway companies to complete their exhibit by sending sections of permanent way, although the Chicago Executive will provide any possible facility for their convenience. In the building will also be exhibited railway signalling apparatus, a refinement of railroad working not so fully developed in the United States as it should be, and in this direction manufacturers of such appliances may find a profitable field. As far as possible all the exhibits will be arranged in groups relating to transportation in historical sequence, while preserving to a large extent a division by nations; in this way the interest of the collection will be largely increased without causing any inconvenience to the various foreign commissions.

XI.—Horticultural Building.

Opposite the wooded island in the lagoon, will be erected the Horticultural Building, a

great conservatory, 1,000 feet in length, and 287 feet in maximum width. The general features of this building are to be a central dome, 187 feet in diameter and 113 feet high. At each end is a large rectangular pavilion, and these wings are connected with the central rotunda by the main body of the building, each side of which is divided into two courts, 88 feet wide by 270 feet long. The courts facing the wooded island are constructed entirely of iron and glass, and will be used for especially tender plants. The rear courts, while they will receive abundance of light, are not entirely glazed; they will be specially adapted for fruit-growing exhibits, which may require a cool temperature. A large section of the courts will be devoted exclusively to the exhibition of orange culture in California and Florida. The central dome will be chiefly given to palms, bamboos, tree ferns, cacti, eucalyptus, &c. Ten miles of 1½-inch pipe will be required to heat the dome alone, and a still greater length will be wanted for the high temperature courts. The ground floor of each pavilion will be chiefly used for fruit exhibits, collections of seeds, and horticultural appliances. Broad galleries will run around these pavilions about twenty-five feet above the ground. The greater part of this area will be used for cafés and restaurants, and as the architectural treatment of the buildings includes an exterior arcade running around three sides—this arcade being extended to the upper storey in the pavilions—an additional amount of open-air space will thus be obtained, whence some of the most attractive views in the grounds will be seen. It is the intention of the chiefs of the horticultural department to encourage the best possible displays of all meritorious exhibits in the various groups of pomology, viticulture, floriculture, culinary vegetables, seeds, arboriculture, methods and appliances of horticulture, &c. As the available space is very limited, a careful selection will be made of the objects accepted. The classification of this department will embrace everything of professional interest to horticulturists, whether they are engaged on a large or a limited scale, and there can be little doubt but that the display will give us as great an impetus to the gardeners' art as did the similar but much more limited exhibit at the Centennial Exhibition of 1876. Already the applications for space in this conservatory from the United States alone, would fill the building several times over, and a system of the most rigid selection is therefore necessary. From Australia and New Zealand, from Latin America, and from China and Japan, applications are already arriving; the most curious exhibits from the last-named country will be the dwarf fruit and other trees, over a century old and not more than two feet high. Many of the States and territories have arranged to make a complete herbarium of their flora, and wax models of all their fruits; it is the intention of the chiefs of this department to make a great collective exhibit of these objects.

I think that there is every reason to suppose that this section will receive very warm and practical support from English horticulturists. Not only is our pre-eminence in the art fully recognised in the United States, but the importation of plants is not saddled with the heavy taxation that applies to most other objects to that country; in fact, all plants intended for indoor cultivation, for the production of cut flowers and for decorative purposes, are admitted free. In the same way many garden seeds are equally unencumbered, and, as will be seen from the following list of exports for 1890, a very large trade is done in them by seed producers in this country:—

UNTAXED EXPORTS.	Value.
Flower and other seeds	£67,000
Trees and plants	114,100
TAXED EXPORTS.	
Bulbs	73,730
Garden and agricultural seeds .	60,400
Plants, &c.	934,990

It will be within the remembrance of many persons who visited the Centennial Exhibition at Philadelphia in 1876, that the rhodedendron displays made by British growers gained the wonder and admiration of millions of American visirors; this exhibit laid the foundation for a large and constantly growing trade in this particular shrub, and I was recently informed by one of the chiefs of this department in Chicago—an eminent horticulturist—that, despite the advance that has been made in America in this branch of culture, we still maintain the lead that we had nearly twenty years ago. In 1876 there were less than a thousand nurserymen in the whole of the United States; this number has been increased more than fourfold at the present time, and the trade in America with cut flowers and decorative plants is enormous. At the beginning of this year there were 4,659 floriculture establishments in the United States, with nearly 39,000,000 square feet of glass. The

value of these establishments is about £8,000,000 sterling, while the value of the plant sales during 1890 amounted to £2,500,000 sterling, and that for cut flowers to nearly £3,000,000. With this very extensive business, with the acknowledged fact that we, as floriculturists, are far in advance of the United States, and with the very favourable conditions that exist, there is every reason to suppose that in this department, at least, British exhibitors may go to Chicago without the least doubt as to the commercial success of their undertaking.

Before dismissing the Horticultural Building, it may be added that extensive grounds will surround it; that these grounds will be laid out in the most elaborate manner, and be adapted for flower displays which will also form exhibits. The art of carpet bedding has been carried, according to our more sombre eastern ideas, to theatrical extravagance in the United States, and while one cannot but admire the ingenuity which tortures foliage plants and brilliant flowers into "Gates Ajar," terrestrial globes, canoes, sundials, and the like, the British landscape gardeners will probably be content with admiration, and refrain from imitating these curious triumphs of floral decoration.

XII.—The Womens' Building.

For the first time in the history of international exhibitions, a special building is to be devoted exclusively to the display of female art and industry. In order that this idea should be carried out thoroughly, it was decided a separate building should be set aside for the purpose, and that the pavilion itself should be the work of a lady architect. The building is in Italian renaissance, and covers a rectangular space 200 feet by 400 feet. The interior of this building, which will have spacious galleries running around the four sides at a height of about twenty-five feet above the ground, will be divided into a number of courts devoted to different sections of industry. Probably the most useful and interesting of these will be those relating to hospital work, rescue organisations, and the helping and care of children by systematic methods. The work of female painters will be for the most part shown in the Fine Arts Building, but is the hope of the committee—consisting, it is needless to say, wholly of ladies—to have a large and valuable art display in a hall that has been arranged for that purpose in the building. Mrs. Potter Palmer, one of the most prominent women in Chicago, is the president of the committee; she appears to have organised this part of the Exhibition with much ability, and during her visit to Europe last summer she did admirable work in exciting the attention and assistance of many public-spirited ladies in this country and on the continent. It is therefore probable that influential committees will be formed in various countries of Europe to co-operate with Mrs. Palmer, and that the display in this building at all events will be international in the widest sense of the word.

I have recently received from Mrs. Potter Palmer a somewhat detailed description of the women's exhibit scheme, and I present an abstract of it here because the project is novel, and will undoubtedly be of high importance. The Board of Lady Managers is the first official body composed of women ever recognised in a grand international enterprise, or endowed with executive powers equal to those bestowed by the liberality of the National Commission; it has also been given funds to execute these unprecedented powers thus bestowed.

"The last session of Congress appropriated for the use of the Women's Board 36,000 dollars for the fiscal year, and will ungrudgingly give as much more as it may ask or need. Indeed, a vote of thanks to the president of the Board and its finance committee at an ensuing meeting of the National Commission, cordially acknowledged their efficient assistance in securing the whole World's Fair appropriation from Congress.

"The Directory—the local portion of the Exposition—having in charge the preparation of the site and erection of the buildings, led the way in splendid generosity to the Woman's Board. It gave the Board first choice of a site, and a magnificent building costing 200,000 dollars. Moreover, the Board was given absolute freedom in the control of this grand structure. Designs were invited from women architects, and the result awaited in somewhat uncertain expectancy. Women were not known in this craft, and the President of the Board confessed an apprehensive sinking of the heart when summoned to assist the Chief of Construction in examining the plans submitted. There were thirteen of them; none were poor, whilst most were excellent, and the principal difficulty was to decide which was the best. Three of the designs were awarded prizes, and then—after the award was made—the interesting fact was disclosed that all the plans were the work of young girls, ranging in age from

twenty to twenty-two. Miss Sophia Hayden, of Boston, won the first prize, and was at once summoned to Chicago to perfect and elaborate the design.

"So much for the exterior of the Women's Building, which is more advanced in construction than any other of the Exposition structures, and which is now practically finished; the interior and contents may now be referred to. Members of the Board have offered contributions to the building, in the form of native materials, in the name of their respective States. The first offer of the kind came from Washington, the youngest State in the Union—Mrs. Houghton, its lady Manager, proffering a granite column. Montana asked permission to give the last nail to be driven in the Women's Building by the president of the Board, promising to make it of gold, silver, and copper, the richest metals of the State. Subsequently the officers of the Board of Lady Managers invited contributions of native materials from the different States, such as fine woods, stone, and marble. Fine woods will be profusely used; proffers of them come from every direction, and there will be much fine carving, which will all be done by women, a condition necessary to gain admission. The reception room will be wainscoted in light wood, and as the panels can be carved separately, the Board will furnish dimensions and also designs, if desired, to any one who wishes to carve a panel. There are also several fine surfaces for mural paintings, to be entrusted to artists of undoubted ability, and workers in metals will also find a fine field. In addition, every one, without discrimination, is invited to contribute whatever she may make, manufacture, or possess in rare, particularly beautiful, or artistic hangings; objects of this description will be returned at the close of the Exposition.

"Any woman exhibiting particular fine work under the general classification, will probably be invited to send something of equal excellence to the Women's Building. By this means, no woman need lose the privilege of appearing in the special exhibit of the Women's Building while exhibiting in the competitive departments of the main buildings.

"Women are given, by the Act of Congress and the generosity of the National Commission, representation upon all juries of award, upon work produced in whole or in part by female labour, the representation to be in accordance with the proportion of woman's work in each department of the classification. The Lady Managers realise that in the selection of these jurors lies a fair test of the fitness of women to be entrusted with an office of such consequence. It is fully aware that the critical eyes of the whole world are upon it; that to fail would be to set back the clock of time half a century for women, while to succeed opens for them a new area of civilisation. Accordingly, the Board will select its representatives with proportionate care and discrimination, searching the United States from the Atlantic to the Pacific, from Maine to Florida, for experts to place in nomination for appointment upon the different juries of awards.

"From its organisation, the Board of Lady Managers has been working ceaselessly, untiringly, and with important visible results in every State and Territory in the Union. It has, moreover, been able to extend its influence beyond the continent, and to enlist in its cause many of the most powerful men and women of Europe. The French Government has voted to appoint women representatives to co-operate with the Board of Lady Managers, and their names will soon be announced. Dutch Guiana has already appointed two women on her Commission. The prospect of recognition in France is excellent; and there is little reason to doubt that it will be accorded in the majority of instances. The women of France and England, and indeed of Europe generally, evince a marked tendency to give their attention chiefly to a showing of philanthropic enterprises, leaving the industrial displays to men, who will have sufficient commercial incentive, without other inducement, to make them. A similar inclination is observed in the work of the Board of the United States. The statistics gathered by its members in this energetic and unprecedentedly close scrutiny into women's work, have fixed startled attention upon certain distressing facts which must assuredly lead to an amelioration of conditions. This was notably true of the Hungarian women working in American mines, and of child labour in various portions of the United States. Powerful labour organisations throughout the country were in communication with the Board during its recent session, concerning the suppression of child labour, the proportion of women's work, &c.

"Particular prominence will be given to exhibits of a domestic, sanitary, educational, and philanthropic description, as representing

the subjects in which women are most deeply interested, and the fields in which they can make the most telling, impressive, and useful showing. The medical director of the Exposition has generously ceded women physicians equal recognition with men upon his staff in the Exposition hospital. This potential fact may be particularly mentioned as indicating the substantial and permanent nature of the Board's influence. The Women's Building will also contain a model hospital fully equipped with physicians and trained nurses, and in connection with it will be the Department of Public Comfort for the treatment of cases of slight indisposition and accidents incident to great crowds. By the courtesy of the Director-General, the Board of Lady Managers will be permitted to establish branch rooms of the Department of Public Comfort in all the main buildings of the Exposition. Without in the least encroaching upon the prerogative of the general hospital, these branches of the Department of Public Comfort will greatly relieve the pressure upon it, and incalculably promote the general welfare.

"The preliminary work in most of the States tended chiefly to securing favourable legislation, towards influencing a liberal appropriation, and official recognition of women upon the State Commissions. Illinois has set a splendid example by placing ten per cent. of her entire appropriation of 800,000 dollars at the absolute disposal of a State Board composed of women. A large proportion of the twenty-eight States which have made World's Fair appropriations and have appointed State Commissions, have given women representation in the same. In a nnmber of States women have taken the initiative in rousing enthusiasm for the Exposition. In various sections the Lady Managers have inaugurated a careful search for the native flora, thus giving valuable assistance to the Chief of Horticulture in making a collection of the plants, fibrous, edible, and medicinal, indigenous to the United States, of a completeness never previously attempted, which will doubtless prove to be a marked feature of the Exposition, and of great permanent value to science.

"A committee was appointed during the September meeting of the Board to formulate a general plan of State work, and to issue printed suggestions for general distribution. One of these pamphlets is now in circulation, and others will rapidly follow. Many helpful hints were mutually exchanged during the reading of the reports of State work at the last session of the Board, and much information pertaining to women's pursuits disseminated. One member explained that the chief difficulty in the way of successful silk culture, an industry in which women are largely interested both industrially and financially, was the imperfection of the reel; and that the best reels now in use were those of home manufacture made by rustic artisans under the direction of Italian women, who are expert in the reeling of silk. Mention was also made of the inauguration of flower farming in South Carolina. This is a new industry in Ameriea, and similar in character to that of Southern France, the flowers being used in the manufacture of extracts, perfumes, and pomades, and the growing of them promises to furnish a profitable, pleasant, and healthful occupation to women.

"America has never made an exhibition at all commensurate with her unparallelled resources, her unequalled extent, and the infinite variety of her climate and products. Perhaps it will not be asserting too much to say that the United States has never made a single or collective exhibit of which there was any sufficient reason to be proud. Nor have the women of the Union ever before been given any very considerable part in the making of a similar enterprise. Now that a progressive Congress and a liberal National Commission, and a generous Directory have placed almost unlimited power in the hands of American women, the Board of Lady Managers, representing every section of the country, are resolved to aid in rendering the World's Columbian Exposition the most magnificent achievement in the history of the Great Republic."

I have devoted so much space to this description of the women's exhibit because it is authoritative, and shows how much in earnest the women of America are upon the subject.

XIII.—Fine Arts Building.

The Fine Arts Building will occupy a site on the north side of the small lake at the northern end of Jackson-park. It will without doubt be one of the most successful pieces of architectural design among all the great and elaborate buildings that constitute the Exhibition. A pure style of Grecian Ionic has been followed throughout; the plan is rectangular, and the building is 500 feet long by

320 feet wide. The rectangle is divided in four large courts by a central nave and transept, which are 100 feet in width and 70 feet in height; at the intersection of these galleries a dome will be constructed about 90 feet in diameter, and occupying the centre of the building. The height to the top of this dome will be 125 feet, and it will be surmounted by a group of colossal figures. The plan of the building thus divided by the nave and transept, will leave four large galleries about 200 feet in length and about 110 feet wide, and a number of smaller courts; these will be reserved entirely for the exhibition of paintings. One court will be occupied by the United States and one has been allotted to this country; the other two are to be given to France and Germany. The clear width of the nave and transept will be 60 feet, as galleries 20 feet in width and 24 feet above the ground will be constructed on either side; the ground floor of the main passages will be devoted to sculpture, and the walls at this level, as well as that of the galleries, will be utilised for mural paintings and sculptured reliefs; space will also be found near the dome for several small picture galleries. Running around the exterior of the building will be galleries 40 feet in width, which will form a continuous colonnaded promenade. The interior will be lighted throughout by skylights, and it should be mentioned that the various courts will be completed ready for hanging pictures, all necessary decoration and shading being provided by the Exhibition authorities. There will be four main entrances to this Art Building, each entrance being so treated as to add to the architectural effect of the structure; the floor level is fixed at such a height as to allow of the introduction of a broad flight of steps at each entrance. The wall of the colonnade running round the building will be decorated with mural paintings that will constitute exhibits, and the exterior frieze as well as the main entrances are ornamented with sculpture and portraits in *bas-relief* of the old masters.

The greatest care has been exercised by Mr. Burnham, the Chief of Construction, in making this building fire proof. No woodwork, excepting that of the panellings and internal fittings of the courts, will be exposed. The framework upon which the architectural effects will be carried, is of course of timber; but this will be so completely embedded in the cement that forms the exterior walls, that no danger need be apprehended. The structure itself is essentially a piece of engineering work; all the main walls are of brick, and the roof, galleries, floor, and dome are of steel; the floors will consist of brick arches turned between the steel girders. In fact, although this building is unfortunately to be temporary like all the others in Jackson-park, as much care is being taken in the construction as will be exercised in building the permanent Art Palace which is to grace the lake front park and constitute the future art museum of Chicago.

The Fine Art Palace is beautifully situated with its south front facing the small lake above mentioned; it will be separated from this by balustrated terraces, and a monumental stairway will lead to the water level and to boat landings that will be constructed there. The north front of the building will face an extensive lawn, beyond which will be the group of State buildings. To the east and west of the main building are to be constructed some one-storied annexes, which will also contain picture galleries. The design of these isolated structnres, which are to be 200 feet long and 120 feet wide, will harmonise with that of the Fine Art Palace. The ground in the immediate neighbourhood of the Art section will be ornamented with groups of statuary, chiefly reproductions from classic and from modern art. The estimated cost of the main building is £120,000; the architect is Mr. P. B. Attwood; the annexes are to be built from designs that were prepared by the late consulting architect to the Exhibition, Mr. George W. Root, whose unexpected and untimely death left a gap in the executive ranks which it was impossible to fill.

XIV.—States and Foreign Official Buildings.

The north side of Jackson-park—that which had been already reclaimed and planted by the Park Commissioners—has been set aside for the use of the various States of the Union which will require separate pavilions in addition to the space which will be allotted to them within the main buildings. If, as is expected, all of the States avail themselves of the facilities thus afforded, there will be forty-eight of these pavilions, each of which, besides containing a certain number of special exhibits, will serve as offices and club-rooms for the State to which it belongs. Already a majority of States has voted considerable sums for Exhibition purposes, and many of the structures will be on a large scale and very elaborate.

The pavilion of the State of Illinois is not included in this group; as the State in which Chicago is situated, it possesses special claims and responsibilities—the claim of occupying a conspicuous position, and the responsibility of making a larger grant than would otherwise have been expected. This she has done, and the advantage of a distinctive site has been accorded by the Exposition authorities. The Illinois building will face the Fine Arts Hall, being separated from it by a small lake. The building will be 160 feet wide, and 450 feet long. Excepting for a space at one end, 75 feet by 60 feet, which will be reserved for a model school house, the interior will present an unbroken rectangular hall, in which the State exhibit will be collected; a memorial hall on one side, and a spacious vestibule on the other, will form wings to the main structure. The architecture is Italian Renaissance, and the principal feature will be a central dome 72 feet in diameter, and about 200 feet high. It will be at once seen that this building will be of quite imposing dimensions, and none of the other States are likely to have so important a pavilion. The whole group of State buildings and their contents, so far as they are open to the public, will be of much interest.

To the south-east of this part of the park is the area set aside for foreign official pavilions. It is pleasant to know that the best location on the ground has been reserved to Great Britain—that on the lake front close by the model battleship. Immediately behind this is the Mexican allotment, and a little to the north is that given to Germany; at the present time no further demands have been made for this space, which, however, will doubtless be filled up before long. The Royal Commission hopes to be able to erect on their land a pavilion that shall be appropriate to the location and worthy of the occasion.

XV.—The United States Government Exhibit.

The present money grant of the Government for the official exhibit is 1,500,000 dollars; of this £80,000 is to be devoted to a pavilion and the remainder distributed in varying sums to the different departments, which will have between them 200,000 square feet of floor space. This does not include the exhibit of the Navy Department, which will be contained in a full-sized reproduction of one of the latest American battleships. The Government building will be a large and imposing structure, upon which, however, no money will be wasted in superfluous decoration; it will be rectangular in plan, 420 feet long on the principal front facing the lake, and 320 feet deep; in the centre will be an eight-sided dome, 120 feet span, and around it will be grouped the spaces for eight Government departments. The State Department will occupy a long gallery, 40 feet wide, leading from the main entrance to the dome, and the Department of Justice is allotted a similar gallery on the other side. On the right hand of the main entrance is the Fisheries Section, 100 feet wide by about 190 feet long, and a similar space on the left hand will be divided between the Post Office and Treasury Departments. In the centre will be the Smithsonian Institute and the Department of Agriculture, and at the back of the building similar spaces will be given to the Department of the Interior and to the War Department; each of these sections will have a floor space of about 125 feet by 175 feet.

XVI.—The United States Navy Exhibit.

The exhibits of all the United States Government departments, with the exception of that of the Marine, will, as just stated, be contained in the public building already referred to, or in annexes built on the adjacent ground, which, it may be mentioned in passing, will also be made use of for various military displays during the course of the Exhibition. The Navy Department, however, has conceived, and is carrying out, an entirely novel scheme, which will undoubtedly prove a great attraction to a large section of the American people who have never visited the eastern or western seaboard of the United States. This is no less than the construction, in the lake, of a full-sized model of a line of battleship; a sister vessel to the *Indiana*, *Massachusetts*, and *Oregon*, which were designed at the Naval Bureau of Construction, and are being built, two by Messrs. Cramp and Sons, of Philadelphia, and the third at San Francisco. An especially interesting feature of the exhibit is, that the model will be built on a submerged platform in the lake, so that from the water line to the tops, it will present in every detail the actual semblance of an armour-clad ship of war. The site selected for this exhibit is shown upon the plan, and you will observe that it is protected by breakwaters against the lake storms, and is situated immediately to the south of the site on which will be erected the British Administration Building, which can repose peacefully under the protection of the wooden guns of this

battleship. The model will be 348 feet long upon the water line, 69 feet 3 inches wide amidships, and it will have 14 feet of freeboard. The hull of the vessel from the submerged platform to the main deck will be built of brick and concrete, finished outside and inside with cement moulded to the contour of the vessel. Beneath the water line an apron of moulded iron plates will extend to shield the platform, so that under no circumstances will the semblance of reality be destroyed. Upon the main deck will be built two armour-plated redoubts, 34 feet 6 inches in diameter, and in each of these will be mounted two 13-inch breech-loading guns. These guns, as well as the redoubts, are built up of a wood framing, finished with cement; the guns, however, will be fitted with a steel rifled tube and breech mechanism, while the carriages on which they are mounted will be so real that all the evolutions of loading and training can be performed. In the same way the mechanism for revolving the turret, handling ammunition, &c., will be capable of being worked. On the upper deck there will be eight 8-inch guns, also mounted in turrets or redoubts, and a battery of Hotchkiss guns will be furnished. The armament will comprise in addition, four 6-inch rifled guns, which are mounted on sponsons built out from the side of the ship; twenty 6-pounder quick-firing guns; six 1-pounder quick-firing guns; two gatlings, and six torpedo tubes. The whole of this minor armament will be real, and the guns will be furnished by the Naval Gun Factory, with carriages, shields, and all equipments in complete working order. An iron military tower will be built at the forward part of the upper deck, and above will be the military tops in which some of the quick-firing guns will be mounted. The conning tower will also be shown completely fitted with all the electrical and other appliances required by the commander in time of action. The bridge, which extends along the whole length of the vessel, carries a number of Hotchkiss guns and the chart-house; on each side of this bridge the boats are hung, and these, together with the cranes, davits, and appliances for working them, will all be actual, so as to form real and working exhibits. Torpedo spars will be fitted to the sides of the ship, so that the operations of manipulating the torpedo netting can be exhibited. A large electric-light plant will be fitted up on board to illustrate the various uses of electric light on board ship. Current will be furnished from the power station of the Exhibition. The quarters for officers and men will be in all respects an exact reproduction of the actual accommodation on these ships; and during the time of the Exhibition the vessel will be manned completely, and, so far as is possible, all the evolutions on board a man of war will be regularly carried out. The remainder of the Navy exhibit will be completed by the engineering department, and the Government will erect on the ground near the vessel one of the great marine engines which is placed in this type of battleship, complete with boilers, shaft, and propeller; the whole of this installation will be kept in motion. The Gun Factory will have a pavilion close by, where heavy guns, armour plates, projectiles, &c., will be exhibited. The Naval Observatory will also put up a building, in which will be shown a large number of scientific instruments belonging to this section of the department. One interesting object in this building is to show the method in official use for transmitting exact time all over the United States, and it will form a central station to a large and complicated system over the whole of the Exhibition grounds. In accordance with an old treaty between this country and the United States, neither Power is at liberty to have more than one ship of war cruising upon the lakes. This section of the American Navy is represented by the entirely obsolete but very hospitable and festive steamer, *Michigan;* while the flag of Great Britain flies over an equally ancient craft. It is proposed, however, with the consent of this country, that this treaty shall be held in suspense during the term of the Exhibition, in order that a number of torpedo boats, and other small war vessels, may be brought to Chicago to illustrate in some degree the new and powerful Navy of which the United States may be so justly proud. The estimated cost of this vessel, which will be called the *Illinois*, is £20,000; it was designed by Mr. Frank W. Grogan under the direction of Captain R. W. Meade, who is the chief of the Navy Department at the Exhibition.

XVII.—The Fisheries Building.

This building will be devoted to fishery exhibits, and its dimensions will be such as to enable a very imposing display to be made. The length of the building will be 1,100 feet, and the width 200 feet; in addition to this there will be two annexes, connected with the main building on each side by arcades. The arrangement for thus dividing the building,

instead of grouping all the exhibits under one roof, was rendered necessary from the form of the ground chosen for the site, the surface of which could not readily be levelled over the whole area. The main building will contain the general fisheries exhibits. The centre will be occupied by a large tank, which will contain a great variety of fish, shells, and marine growths, so arranged as to make it a specially attractive object; in the centre will be a fountain. The exhibit will be arranged around the tank on the ground floor, and in suitable galleries in the upper stories. Other large ponds will be constructed in connection with the building in which specimens of the larger fish, such as sharks, sword-fish, &c., are to be induced if possible to disport themselves. One of the annexes will be devoted to angling exhibits, and the other to an aquarium, which is to be partly underground, and to be on an unusually large scale. The architecture of the building is "Spanish Romanesque," and considerable hardihood and ingenuity has been shown by the designer in combining elaborate decoration in the capitals, medallions, &c., in which fish are introduced as the leading feature. The design is certainly a pleasing and an ornamental one, and the effect of the materials imitated—dark brown stone for the walls, and old Spanish tiles for the high roof—ought to be excellent. The architect is Mr. H. Ives Cobb, and the cost is estimated at £75,000. Judging from the wonderful advances that have been made in all matters relating to fish culture, and the capture and utilisation of fish in the United States, this section of the Exhibition will be of high interest. The Fish Commission will show a separate collection in the Government Building.

XVIII.—The Midway Plaisance.

The Midway Plaisance is a strip of ground about 600 feet in width and a mile in length, that connects Jackson with Washington-park. The junction with the former is at the point shown on the plan, immediately opposite the Women's Building. This extensive piece of land, at present almost waste, is to be converted to various uses that may perhaps be best described as a Street of Nations. Here will be collected all, or nearly all, of the Auxiliary Exhibitions, to which admittance will be gained by extra payment—theatres, panoramas, Oriental amusements, and the like. It is to be a Bazaar of all Nations, for it is only in this part of the Exposition that current sales will be allowed. Native villages from various civilised and uncivilised parts of the world will be organised, to gratify the curious, or instruct the student; refreshment booths and beer gardens will not be wanting, and probably more than one of those ingenious reproductions, initiated some years ago by the inventor of Old London, and since so often and so successfully repeated, will find a profitable if short existence on the Midway Plaisance. There is little doubt that this portion of the Exhibition will always be crowded, just as the famous Rue de Caire at Paris, in 1889, was usually impassable. But this Bazaar of all Nations will be on a much larger scale than the Rue de Caire, and a railway running down the whole length will be a necessity. The concession for this railway has been granted to the proprietors of the sliding water railway that attracted so much attention in Paris, and no doubt a proportionate degree of success is awaiting it in Chicago. Already a considerable amount of space has been allotted in the Midway Plaisance, and no time should be lost by those who wish to avail themselves of the opportunity it affords being present. I am informed that already concessions for twenty panoramas have been granted. It is at the junction of the Midway Plaisance with Jackson-park that the great Columbian Tower is to be erected. Of course this tower is to be higher than that of Eiffel, it would not otherwise be worthy of the occasion or of Chicago; it will be 1,120 feet in height, and from its summit the visitor will be able to see the city limits of Chicago. That it is the work of a well known American engineer—Mr. George S. Morison, is a sufficient guarantee of its stability, though probably the foundations will be a far more difficult matter than those of Paris. It is said that Mr. Carnegie, the famous American steel maker and capitalist, is at the back of this enterprise, for the completion of which there does not seem very much time.

XIX.—The Pier.

From the southern side of the Grand Avenue a pier has been constructed extending into the lake for a distance of 180 feet, where it terminates in extensions to the right and left of about the same length; the outer side of this pier head is protected against the lake storms by a breakwater, and on the north side another breakwater with sufficient openings will be constructed from the pier head to the shore, forming an enclosure 1,800 feet long and about

1,000 feet wide. This large water area will be utilised for the smaller floating exhibits, and as it will be entirely protected it will doubtless be a favourite place for boating and other aquatic amusements. The pier will serve as a landing place for the extensive fleet of fast passenger steamers, which will be the pleasantest means of transport between the city and Jackson-park in favourable weather. It will also serve for the convenience of visitors making use of the fast electric launches which are to ply for hire about the harbour, through the great basin and in the canals. It is expected that these launches will be a very useful means of circulation in the grounds, and they will accordingly be provided in very considerable numbers, and landing stairs will be constructed at convenient places. Probably the fleet which Columbus navigated across the Atlantic 400 years before, and which is now being reconstructed as nearly as historical data permit, will be moored in or near the harbour. It was intended that at the shore end of the Grand Avenue the basin should terminate in a semicircular embankment with wide waterways, affording ample communication between the harbour and the canal system in the grounds; around the outer edge of this semicircle was to be placed a row of thirteen columns, each surmounted by the device of one of the thirteen original States of the Union. Rising from the water in the basin will be a colossal statue of Liberty; this statue is being designed by Augustus St. Gaudens, of Paris. At the pier head was to have been built a casino containing a restaurant and music-hall. It is probable that this part of the scheme will be modified, and that the most of the pier head will be utilised for restaurants. Certainly the most attractive view of the Exhibition will be obtained from this spot. Looking shoreward across the blue water of the harbour, full of colour and animation from the numerous and varied craft which will be moving on its waters, the visitor will see before him the whole extent of the Grand Avenue and the beautiful façades facing it; on his right will be the long front of the Industrial Building, thrown into relief by a series of small and elegantly-designed cafés that will stand between it and the lake; beyond will be a view of the Government reservation, with its encamped soldiers and many suggestions of the United States army; the great model of the battleship will be full in view, and beyond the perspective will be closed in by distant glimpses of some of the larger buildings and the confused picturesqueness of foreign administrative buildings and the pavilions of the various States. To the left the Exhibition will offer but little that will be attractive, the ground south of the pier being occupied almost wholly by the agricultural exhibit. There will, however be one notable exception to relieve the poverty of this portion of the view. On a tongue of rising ground projecting into the lake will be built a copy of the Convent of La Robida at Palos, so closely associated with the history of Christopher Columbus.

During the last few weeks an important alteration has been made in the design of the Exhibition, so far as concerns that part of it on the eastern end of the Grand Avenue adjoining the pier. The original design has just been referred to: a casino at the end of the pier, and the semicircular mole, surmounted by thirteen columns, at the shore end of the Grand Avenue. Both these features are to be abandoned, and the money which was to be spent upon them—£41,000—is to be devoted, to two buildings, each 140 feet by 200 feet, on the north and south side of the basin; these will be connected by a colonnade, 60 feet wide and 500 feet in length, something like that leading to St. Peter's at Rome. One feature of the colonnade will be the introduction of 48 columns, representing all the States and Territories. Where the colonnade crosses the basin, this latter will be spanned by a high and wide arch, giving free access from the harbour to the canal system of the grounds. One of the new buildings—that at the northern end—will be used as a music-hall, and sitting accommodation will be provided for 2,000 people, with an orchestra of 75 instruments and a chorus of 300 performers; there will also be a hall for rehearsals, to accommodate 600 people. The music-hall is not intended so much for popular concerts as for select performances, and it will probably be in this building that the Musical Congress, the general outline of which has lately been announced, will be held. The building at the south end of the colonnade will serve as a restaurant. In the south end of the park will be provided accommodation for the more general musical entertainments, such as grand choruses, grand concerts, and band concerts. In a special building accommodation will be provided for 15,000 persons. This structure will be known as the Live Stock Amphitheatre or Show Ring; it will be situated in the Agricultural section of the grounds, and be used for the above-named purpose after the series of projected musical entertainments

has been completed. There can be no doubt as to the improvement that will result from this alteration; the pier head will certainly be a favourite place of popular resort, and restaurants will probably be found there. Mr. Attwood, the architect of the Fine Arts Building, has designed these alterations.

XX.—The Department of Decoration.

Some reference should be made to the method which has been adopted for insuring harmony of decoration throughout the entire Exhibition; this has been done by creating a Department of Colour under the charge of an experienced artist, whose duty it is to superintend, not only the whole of the constructive ornamental work, but also to decide upon the colours which shall be used in the decoration of each building, with proper regard to the effect produced on the building itself, and the part it has to play in the general scheme. This novel and responsible position is filled by an Englishman, Mr. William Prettyman, who is ably sustaining the reputation of his country in the decorative arts. The post is a very onerous one, as the purely artistic part of the work forms only a small portion of Mr. Prettyman's duties. He has under his charge the very extensive art studios at Jackson-park, where workmen of all nationalities are engaged in modelling the reliefs and other decorations, which will be employed in such large quantities upon the buildings; moulds in elastic composition are taken of these models, and in them are cast the reliefs in cement. As there will be an enormous amount of mural painting, mosaic pavement, internal decoration, and later on, all the rich effects to be produced by flags and other vehicles of colour, it will readily be imagined that the post is no sinecure.

A few days ago I received from Mr. Prettyman a description of the general plan of decoration he has composed for the Exhibition Building, and as this is of considerable interest, a short notice of it is given in this place. The great buildings surrounding the Grand Avenue will be of one tone, that of yellow, approximating to old alabaster, the surface of which has begun to disintigrate. On approaching the informal lines of the lagoon and wooded island to the north, the buildings are cut off from the Grand Avenue by another scheme of colour. The Transportation Building will be painted with the colours of Spain, which was the first country to provide means of transport to the New World; the tones will be gold, yellow, and red, but not so brilliant as those of the national colours. The Horticultural Building comes next; this will be a mass of glass, and the walls will be tinted ivory colour, warmed with a slight rose tint. The Women's Building will be of a yellow ivory tone, blended with a very delicate orange, and the roof will be red, making a contrast to the roofs of larger buildings, which are of a *vert-de-gris* colour, like old copper bronze. The Fine Arts Building being purely classic, and reflecting the architectural motives of the buildings in the Grand Avenue, will be of the same tint as those buildings; the dome will be covered with tiles of torquoise blue. The Fisheries Buildings will be coloured outside in a manner corresponding to the interior colouring of the Cordova Cathedral; the archivolts will be picked out in red blocks on a dull buff ground; the roofs of this building will be of marine blue. Returning to the Industrial Building, there will be eight grand entrances; four of which will be decorated with sculpture, while four will have mural paintings, suggesting the contents of the buildings. Large panels will be placed in the timpani of the arches over these entrances; they are segments of a circle 30 feet in diameter. The interior of this building will be so vast, that beyond a certain height it is not probable that any attempt will be made to decorate the great space over head, excepting to paint it of a light tone, which will serve to reflect the electric light in at night. A good eye line will be taken, such as gallery fronts, and these will be treated with a good deal of modelled work sufficiently strong in colour to give animation, while broad gold and coloured lines will be placed on the lower portion of the roof. This plan will be carried out in most of the large interiors. Special decoration will be concentrated at certain points of the exterior of other buildings; thus the main entrance to the Agricultural Hall will be formed by a temple of Ceres; in the centre will be a statue of Ceres, surrounded by a colonnade and domed roof, all of which will be richly expressed in gold and colour, and there will be a mosaic floor in black and white to emphasise the Ionic character of the building. The entrance to the Mines Building will be of marble and mosaic, the decorations being in gold, silver, and black, colours emblatical of mineral products. The grand entrance to the Electricity Building will be a magnificent hemicycle, which is to be made as brilliant as possible for night effect, by the use of porphyry

columns, and great masses of gilt modelled work in relief; a gigantic statute of Benjamin Franklin will stand in the centre of this entrance. Little or no decoration will be given to the Machinery Hall, the idea being that its appearance should harmonise with its contents. The main entrance to the Transportation Building will be a great arched doorway, covered entirely with gold, intensified by strong reds and blues. The interior will be very simply treated with elementary byzantine decoration. The Fine Arts gallery, which will have a mile of hanging space on the walls, will have little internal decoration; the hanging spaces will be of the usual dull red found most suitable for the purpose. But at the entrance and under the central dome, gold, colour, and decorative figure work will be freely used. As for the Administration Building, its roof will be covered with aluminium bronze highly burnished, and its decorative scheme is that of a monument to great discoverers. Outside there will be eight large inscriptions, detailing facts in the life of Columbus, and forty names of discoverers of continents, or portions of continents. Inside there will be eight records of important discoveries in science, and as many names of great men of science. The dome will be lined with suggestive *bas-reliefs*, and the whole effect of the interior is to be simple, grand, and dignified. The internal decoration will consist of *bas-relief*, forcing the colonnade into view by flat panels, and the relief that gold will give to certain strong construction lines.

XXI.—The Exhibition Grounds.

Allowing for the 150 acres of main buildings upon Jackson-park, and for the large number of smaller and independent pavilions that will be erected there, there will still remain an area of about 400 acres within the park limits. A small portion at the northern end has already been reclaimed and laid out by the Park Commissioners; the remainder is a work that has yet to be completed, and this is in the hands of the famous American landscape gardeners—Messrs. Olmstead and Codman, who are widely known by their successful treatment of Central-park of New York, the Buffalo-park at Buffalo, and many others. In the arrangements of Jackson-park a considerable space will, as we have seen, be occupied by water—by the great basin, the canal, and the lagoons. The banks of all these will be either sloped or terraced, and marked by very numerous landing stages for the fleet of electric and other boats. Many miles of walks will be laid out in the park, the main thoroughfares being paved by artificial stone blocks, the exact nature of which has not yet been decided upon. At the present time, of course, all is chaos in the park, but before long the partial restoration of the surface soil, stripped for levelling purposes, will have to be commenced, and the planting of trees, which will be done with a liberal hand and with a view to the best effects, will be started. Enough excavated material from the basin and canals will be at hand to change the dead level of the ground as may be required, and in due time the lawns and flower beds will be formed. Much attention to effect will be concentrated on the terraces bordering the great basin, but the chief work of the landscape gardeners will be concentrated on the wooded island, a large area of land in the lagoon opposite the Horticultural Building. This spot, on which there already exists a certain number of trees, will be liberally planted with specimens of every suitable tree indigineous to the United States, while the ground will also be planted with azalias, rhodedendrons, and other flowering and decorative shrubs. There is no fear that the Exhibition Buildings will not receive a suitable setting, while beyond the busy and motley throng of all nations, the visitor seeking quiet and repose will find these in the wooded glades, and beside the clear waters of the lakes in Washington-park.

XXII.—The Exhibition of Relics of Columbus.

Mention has been made in another part of this paper of the reproduction of the Convent of La Robida, which is to be constructed on an elevated tongue of land projecting into the lake to the south of the pier; it was in this convent that Columbus found long and frequent intervals of rest and shelter. It is a part of the Exhibition scheme to do all possible honour to the memory of the great explorer, whose four hundredth anniversary is to be celebrated, and to make as complete a collection of the relics of Columbus as time, money, and labour, will permit. The work is, I believe, chiefly if not wholly in the hands of the Government, at all events it comes into the Latin-American Department of the Exhibition, and is placed under the control of a Government official, Mr. W. E. Curtis. The project is a very comprehensive one, and I am enabled to give a somewhat detailed account of it, which I do with much pleasure, because it will be found of interest, and because it

may be the means of inducing those who may be possessed of Columbus relics to lend them for the enrichment of the collection. The first part of this historical exhibit will include maps, models and *fac-similes*, intended to illustrate the condition of navigation and the knowledge of geography before and during the time of Columbus. This section will also comprise such evidence as is available of the discoveries that are alleged to have been made at an earlier period, whether by the Scandinavians, Danes, Welsh, Irish and other nationalities. Here the famous Leif Erikson will be thrown into relief; his statue will form part of the exhibit, and near it, maps and charts of his alleged voyages, and the settlements which it is claimed he made in Greenland; the localities associated with his name will be shown by photographs, and there will be a number of models of the Norse ships of his period. There will be a very fine collection of navigating and other nautical instruments in use before and during the time of Columbus, and the department is now trying to induce the Danish Government to send over, as a part of its exhibit, the original sagas of the Norsemen; there is a good chance of this being done. Finally, in this historical section there will be a large and very interesting collection of charts, including all the known ancient maps, either the originals or copies, from the earliest representation of the earth by the Hindus, to the globe of Martin Boreheim at Nuremburg; probably the original of this latter which exists in the Town-hall of Nuremburg will be lent.

The life history of Columbus follows this more general section. This collection will include illustrations of the various cities that claim him as their son—Cogoletto, Quinto, Genoa, and others; models of all the houses in which he was supposed to be born will be given; there will be photographs of the University of Pavia, where it is stated that he was educated; his life in Portugal and in Madeira is followed step by step, until he became associated with Spain, and in this connection photographic and other views will be shown of all towns and buildings with which his name can be linked. This stage of the story includes the Convent of La Robida, in Palos, which is to form the casket in which so many priceless gems are to be enshrined. As you are aware, Palos is a little seaport in the Spanish province of Andalusia; it faces the Atlantic, and it was from Palos that Columbus started on his first voyage on the 3rd of August, 1492. An extensive picture gallery will next attract attention; in it will be arranged all the paintings—either originals or copies in which Columbus figures, and as these are very numerous, and the subjects very varied, they will present an almost continuous, though, perhaps, not harmonious, life story of the great voyager. A separate room of this gallery will contain all the alleged portraits of Columbus that can be collected and which have any artistic merit; already forty-five of these portraits have been brought together, and it is probable that the student of the really remarkable series will be sorely puzzled to know what manner of man the discoverer of America was. Supplementary to the Columbus picture gallery will be another referring to the court of Ferdinand and Isabella at the time of Columbus, with a large collection of historical portraits.

Probably the interest in the collection will centre in the model of the *Santa Maria*, the caravel in which Columbus sailed from Palos on his first voyage. The *Santa Maria*, as well as her consorts—the *Pinta* and the *Nina*—were small and ill-found ships, actual particulars of which either do not exist or have not been discovered. We may, however, expect that much more will be known about them before long, as an officer of the United States Navy has been instructed to obtain full information, and afterwards to reconstruct a correct model of the *Santa Maria*. Lieut. Little, who was told off for this pleasant task, has, I presume, succeeded, for I am informed that he is now in Spain, where he is occupied in building the caravel; should time and funds permit, both the *Pinta* and the *Nina* will also be reconstructed, and this copy of the famous old-world fleet will be navigated across the Atlantic. It is intended that this ship, or the whole fleet if it is built, shall take a part in the great Naval Review which is to be held in New York Harbour in 1893, and to which all the maritime governments of the world have been invited to send their ships. The *Santa Maria*, on that occasion, and afterwards during the term of the Exhibition, will be manned by Spanish sailors in the costume of the time, and she will be rigged and equipped as nearly as possible (except, we presume, as concerns rations) as she was during her first voyage. After the Naval Review the caravel will be taken through the canals and lakes to Chicago, where it will be anchored beneath the walls of the Convent of La Robida during the period of the Exhibition.

Fac-similes of all the busts, monuments, and statues of Columbus that are known throughout the world are to be reproduced and shown, as well as models of his two burial places in San Domingo and Havana; as the first named place possesses a casket containing his alleged bones (which will also be represented), it may possibly have the greater claims to the privilege.

Thus it will be seen that it is the intention of the Latin-American Department to present a complete life-interest of Columbus, so complete indeed that it would probably astonish the great Admiral with many of its details. It is pretty certain that after so much painstaking investigation, the history of Columbus will have to be re-written.

Following these more showy and attractive exhibits, will come the section of bibliography, which will illustrate by what means a knowledge of his discoveries was communicated to the world. The geographical results of his voyages will be shown by a collection of maps and charts, from the earliest sketches down to the political divisions and the topography of North and South America of to-day. Exhibits to elucidate the reasons that gave America its name will be presented. Amongst other objects in this class will be a copy of the first edition of the *Cosmographiæ Introductio*, published at St. Die, and to which the continents of the new world owe their name. This famous book will be placed in a glass case in the centre of a room, and around it will be arranged a collection of illustrations of the place where the book was printed, with portraits of the authors and publishers, and of the patrons under whose auspices it was produced. I believe that Mr. Curtis is very proud of this collection, which is remarkably complete, a success due, so he informs me, to a series of fortunate accidents. With relics and records of Americus Vespucci and other early travellers, the personal part of the exhibit is completed, and the continent of America is taken in hand. There will be a great relief map of the two continents, on which will be laid down the various routes of Columbus, and the different places visited by him will be marked. To give increased interest to this part of the exhibit, photographers were dispatched from Washington to such places, and a large number of views are being taken that will illustrate the present condition of every spot he is known to have visited, including the West Indies, the north coast of South America, &c. By ethnological and archæological collections the conditions of the natives of these various countries will be indicated, as well as the impressions received about them in Europe from the early voyagers' reports and travellers' tales. This section will be enriched by drawings and descriptions copied from De Bry, Philipono, and other imaginative writers of the time who published fantastic representations of the original inhabitants of the continent.

Relics—that is, personal relics—of Columbus will be plentifully displayed. The ruins that marked the site of Isabella, the first settlement of the New World, have been acquired and are to be re-erected. An authentic anchor, and a cannon that he left behind him at Navidad, where he built a stockade from the wreckage of the *Santa Maria*, and the actual bell that was hung in the church tower of Isabella, and for the first time rung out on the breezes of the western world the tidings of a new religion, and of new phases of cruelty and persecution. These interesting mementoes are already in the possession of the department, and it is expected that many more will be acquired or lent, especially by the Spanish Government and by private collectors.

Finally will come illustrations of the conquest of Mexico and of the Colonial period, both treated in the same broad and complete manner; the former is divided into three epochs. First is the epoch of the conquest of Mexico; this will comprise (*a*) the civilisation of the Aztecs, illustrated by actual collections, by models, and by photographs. (*b*) The Conquistadores: Cortez is the hero of this section of course, and a large and very interesting museum of relics of that great adventurer will be arranged. (*c*) The epoch of the Conquest of Peru: this will include subjects to illustrate the civilisation of the Incas and the career of Pizzaro and his followers. Authentic relics of this period are quite numerous; the sword of Pizzaro is in the Royal armoury at Madrid. His banner, which it is claimed was embroidered by Queen Isabella, was cut in two; one half is preserved in Bogota, Columbia, and the other is at Caracas in Venezuela. (*d*) The epoch of conquest in other parts of America: in this will be collections to show the condition of the early natives of Central and South America; relics of the first discoverers and travellers, and collection of antiquities from all the republics of South America.

The third group refers to the Colonial period of the same continent. It commences with

the epoch of the Spanish Viceroys, and is intended to illustrate especially the development of the southern continent from the time of the conquest to that of the revolutions. Naturally religious relics will play an important part in this group, including as many genuine objects connected with the Inquisition as can be obtained. The epoch of the revolution will refer to that stormy period of South American history when the colonists rose up against the parent countries and threw off their yoke prior to commencing their own internal wars. Probably this section will be very complete, though hardly so interesting as the ones that precede it.

Too much praise cannot be accorded to Mr. Curtis for the ability and enthusiasm he has brought into this work; the success following his efforts is already assured, and we may predict in advance that the contents of the model La Robida will be worth the journey from here to Chicago to study. But I have another motive besides that of attempting to render justice to Mr. Curtis, and which I feel I have not sufficiently done. This really marvellous effort has other objects than to do glorious homage to Columbus, or to provide a special attraction to the visitors at the Exhibition. It is the avowed and absolutely justifiable intention of the United States to draw as closely to itself as possible, the countries of South America; and this embodiment of their history, this worthy homage fully paid to the great past of Spain and of her old colonies, will be a substantial step towards the realisation of that dream of federation so dear to most Americans. The struggle between ourselves and the United States for trade supremacy in those important countries which we have been accustomed carelessly to regard as ours by vested right, is close at hand, and the Columbian Exposition is assuredly going to mark an epoch in our commercial relations with South America. The sympathy between that continent and the United States is very sincere, and is based on an actual or a supposed community of interests; that it is real, the following facts and figures willl show.

United States Army and Navy officers have been sent by the supreme Government to every one of the republics and the colonies, as Commissioners, to awaken their interests, and to aid and direct the work of the various Governments and the local commissions; what excellent commercial missionary work these gentlemen will do, perhaps even without intending it, is obvious to you all. Every South American republic, and nearly every colony, has appointed Commissioners, and most of them have made large grants. In all, these grants amount now to over £400,000, and will be yet increased. In Brazil, the Federal Government has voted £100,000, and the different districts have also made large appropriations. It is true that the spectre of revolution is ever menacing this turbulent continent; but even revolution cannot destroy, it can only arrest, the flow of commerce, for which the United States is so actively digging a new channel. Columbia and Ecuador have each subscribed £20,000; Peru, Bolivia, Chile, Costa Rica even, the same amount; Argentina has found £200,000 (there is always money for war or exhibitions); Nicaragua, Guatamala, Honduras, Mexico, and Uruguay are all pressing forward with Commissioners and funds. The President of Paraguay has received *carte blanche* from his Congress to expend what he deems necessary; and the West India Islands are following suit.

Are stronger indications than these required to awaken our manufacturers to this concerted attack on one of our great trade strongholds? I repeat that this effort of the United States is absolutely fair and frankly announced. And I desire to emphasise the fact that in pressing us to participate in their Columbian Exposition, the Americans show their wish to give us every chance. This is no fanciful picture of the danger we incur, that I have attempted to sketch, and with this warning to our manufacturers and our traders, I pass on to another subject.

XXIII.—The Ethnological Museum.

If the plan which has been elaborated by Professor Putnam is carried out, a very complete ethnological exhibit will be made. It is intended to find room for this display in the hall of the Liberal Arts, but it is a question whether there will be sufficient space in this vast building. Like the historical portion of the transportation exhibit, that of the Columbus relics and some others, the ethnological collection will have little or no commercial interest, but only a scientific value. Foreign co-operation, therefore, will be entirely disinterested, and in order to awaken the interest of those connected with this subject, too much publicity cannot be given to Professor Putnam's plans, in the elaboration of which he is hoping to obtain aid from different parts of the world. He was appointed Chief of the Ethnological Department last September, and a grant of

£30,000 was made to defray the expenses of the exhibit. The most important part of the collection will refer to North and South America. Commencing with the traces of the existence of man in the northern hemisphere, and south of that part which then lay beneath a sheet of ice, the conditions of human existence will be represented by illustrations that will include the geology, the flora, and fauna of the period; the latter will contain actual specimens or reproductions of the mammoth and the mastodon, the reindeer, musk ox, and other animals which then existed far south in the continent. Portions of human skeletons and relics of human work have been discovered in the glacial gravel of this early period. After this will follow an exhibit of the races which still inhabit arctic regions; their summer and winter houses, boats, dogs and sledges, utensils, weapons, and costumes, as well as life-size figures of men, women, and children. Other collections will illustrate the northern tribes on the west side of the continent, Indian tribes living in the interior, and, as far as possible, by means of actual relics or by reconstruction, the habitations, arts, and customs of the various tribes living in the eastern portion of the country at the period of its earliest settlement by Europeans. This will be chiefly obtained by information gathered from 15th century writers, from old village sites, and from native burial places; so, also, the tribes of the southern portions of North America, of Central and South America, will be represented as fully as time and means permit.

Most of these objects will refer to periods of which tradition, history, and actual relics have handed down evidence. But there exist in America wide and deeply interesting evidences of pre-historic life on the American Continent; models of the most important earth works and mounds of the central portion of the country will be prepared, as well as carefully made plans and sketches. The great earth works in Ohio, in which are combined squares, octagons, circles, and other figures, often of large size, will be represented in this way as well as the different kinds of mounds. A model will be made of the great mound Cahokia, nearly a hundred feet high; another will be shown of the great serpent mound of Ohio, an earth structure 1,400 feet long, and the symbol of ancient worship in North America. The immense mounds, representing man and various animals, of which several exist in excellent preservation in Wisconsin and Minnesota, will be reproduced, and this part of the subject will be further illustrated by plans and drawings of all the important mounds known in North America. Associated with these objects will be a museum of the contents of the mounds; implements and ornaments of stone, copper, silver, bone, and other materials that were fashioned and utilised by this ancient people.

Another class of exhibits will be models of the ancient cliff houses and ruined pueblos of Colorado, Arizona, and New Mexico, with a large collection of ancient pottery, implements, and ornaments taken from them; models of the existing pueblos, such as those of Moki and Zuni, which appear to form a direct link with the past races, of which only ruins remain. Then will come the reproduction of some portion of those great stone buildings in Central America, Mexico, and Peru, of which there is but little knowledge. The ruins of Yucatan afford rich material for this part of the subject, and will be illustrated by reproductions, models, and pictures of this ancient architecture, and of the hieroglyphic records that abound within the temples; one of the most important of these structures, known as the Portal of Baoma, it is intended shall form the entrance to the great court in which all these objects will be arranged. To give an air of life to these relics of a dead and vanished time, many groups of natives, selected from different tribes of north, central, and south America, will be brought to Jackson-park, where—living in their own huts—they will be engaged during the period of the Exhibition in following their special industries, such as pottery making, weaving, basket making, &c.

Such a scheme as has been sketched out in the foregoing lines, from information furnished by Professor Putnam, suggests the necessity of much labour and of very earnest co-operation. In this Professor Putnam has been fortunate in obtaining the colaboration of Mr. W. E. Curtis, of the State Department, and chief of the Latin-American section. This gentleman, many months ago, despatched agents to all the countries of South America in connection with his own special work, and these are also engaged in gathering material for the ethnological display. The various museums from the different States of the Union are also assisting, as well as the various consuls in Mexico and Central America, while an expedition has been despatched to Greenland, Alaska, and Siberia for the same purpose. Special commissioners have also been sent to various parts of Asia and Africa to collect

ethnological material. The work is, therefore, proceeding with energy and method, and it is hoped that the appeal for help to the scientists of this country and on the Continent will not be in vain. It is intended after the Exhibition to establish a permanent ethnological musenm at Chicago.

XXIV.—Protection against Fire.

We have heard a good deal about the danger to which exhibits in Jackson-park will be exposed, from the alleged inflammable nature of the buildings. I should like to dispel this belief, which has no foundation in fact. It was originally contemplated to employ timber for the roofs of all the buildings excepting those of large span, and had this been done there is no doubt that during the hot and dry summer season there would have been considerable fire risks. But all this has long since been changed; it is true that the foundations, walls, and general frame work of nearly all the buildings is to be of wood; but the roofs, excepting those of quite insignificant dimensions, will be of steel, and there need be no more apprehension of fire than there was during previous exhibitions held in London or Paris. The exterior and interior of all timber walls will be covered with a fire-proof plaster, and all the complicated framing upon which the elaborate architectural effects are built up, will be embedded in the same material. Within the various buildings, timber, where it is exposed, will be protected with a fire-resisting paint; in short, every precaution that care and skill can suggest will be employed to secure the safety of the structures and their contents. In connection with this subject, some very interesting experiments will soon take place in Jackson-park. Some time since every paint manufacturer in the United States was requested to join in a test of so-called fire-proof paint. Only seven firms responded to this appeal, and a series of small wooden buildings are now being erected to put the pretensions of these makers to the proof. They will be covered with match-boarded roofs, over which canvas is strained, and they will be painted with various compositions inside and out. Efforts will then be made to set fire to these sheds by means of powerful electric currents flowing through defective conductors; such of the buildings as resist these tests will afterwards have combustible materials steeped in kerosine placed within them, and set on fire. The contractor whose paint is proved by these experiments to be the most resistant, will supply the executive with their compositions. Some of the competing firms have already carried out experiments on these lines, with reputed success. It need hardly be added that the amount of paint required to protect the exposed timber work within the buildings will be enormous.

Doubtless, these experiments will be of extreme interest, and very instructive. The Executive will, however, do well to remember that, with conflagrations, as with many other things, it is always the unexpected which happens, and that, despite all their care, a hundred unforeseen causes may exist to start a fire in one part or another of Jackson-park. Probably defective electric conductors will be a most fruitful source of danger, and, as such an enormous amount of energy will be constantly distributed through some hundreds of miles of wire, the risk from this cause will be largely increased. It is intended that the organisation for the prevention and extinguishing of fires shall be as perfect as even the advanced practice in the United States will admit. Mains are being laid down throughout the grounds, to which branches are connected, and a great number of fire hydrants are attached. The water supply will be practically inexhaustible, and the pumping power amply sufficient to meet even extraordinary contingencies. At the present time, this service is being placed in working order; for there is probably more danger from fire during the erection of the buildings than after the Exhibition is opened.

A powerful combination of insurance companies will issue policies covering risks upon the buildings, and, later on, upon the contents. And it is said—though I do not make this statement with official authority—that a floating insurance of 300,000,000 dollars will be effected by the Executive upon the Exhibition and its contents during the year 1893.

In addition to the fire service, the water supply for innumerable requirements during the time of the Exhibition will be—and it may here be mentioned that it is intended that the sanitary arrangements shall be—entirely satisfactory. The sewage will be collected by mains from all parts of the ground, and delivered into tanks near the lake, where it will be subjected to chemical purification; and only the effluent water will be discharged into the lake. Provision will be made for testing different systems of treating sewage that may be extracted.

XXV.—Classification of Exhibits.

A special committee was nominated at Washington to determine the general scheme, and to work out in minute detail, the system of classification which should be adopted for exhibits at the Columbian Exposition. The principle adopted was that of classification by objects, the intention being that objects of the same class should be arranged together, whether sent by American or foreign exhibitors. This method has been definitely abandoned, the Executive having realised the extreme inconvenience, not to say impracticability of foreign exhibitors having their goods scattered over numerous departments throughout the Exposition. Of course a certain amount of subdivision is absolutely necessary; for example, machinery must be shown in the Machinery Hall, pictures in the Fine Arts Gallery, agricultural exhibits in the section reserved for that purpose; and objects relating to the industrial arts, in the Industrial Arts Building. But apart from these broad lines of classification, the Chicago Exposition Executive impose no regulations upon foreign exhibitors, excepting that they shall follow the official classification of their goods in the spaces that have been reserved for them in the several buildings. It is understood, so far as this country is concerned, that we are at liberty to place—with the exceptions above referred to—all our exhibits within the great Industrial Hall, where the area of our court covers 120,000 square feet; it is also understood that if the British exhibits be sufficiently numerous to require a greater space, such exhibits shall be placed within the buildings to which they officially belong, and, to provide for this desirable contingency, ample space has been reserved by the Executive within these buildings.

Turning to the official classification, we find that the exhibits are divided into twelve departments; these departments being divided into groups, and the groups into classes, of which the following is a summary:—

Department A.—Agriculture, Forest Products and Forestry, Machinery and Appliances (Class 1 to 118).—In this department, Group 1, is for cereals, grasses, and forage; Group 2, bread, biscuits, pastes, starch, gluten, &c.; Group 3, sugars, syrups, confectionery, &c.; Group 4, potatoes, tubers, and other root crops; Group 5, vegetable products of the farm not otherwise classed; Group 6, preserved meats and food preparations; Group 7, the dairy and dairy products; Group 8, tea, coffee, spices, hops, and aromatic and oleaginous vegetable substances; Group 9, cotton, flax, wool, silk, and other fibrous and hairy substances; Group 10, pure, and mineral waters, natural and artificial; Group 11, whiskies, cyder, liqueurs, and alcohol; Group 12, malt liquors; Group 13, machinery, processes and appliances for fermenting distilling, bottling, and storing beverages; Group 14, farms and farm buildings; Group 15, agricultural literature; Group 16, farming tools, implements and machinery; Group 17, miscellaneous animal products—fertilizers and fertilizing compounds; Group 18, fats, oils, candles, &c.; Group 19, forest products—forestry.

Department B.—Viticulture, Horticulture, Floriculture (Classes 119 to 171).—Group 20, viticulture; Group 21, horticulture; Group 22, floriculture; Group 23, arboriculture; Group 24, pomology; Group 25, preserved fruits and vegetables; Group 26, appliances and methods of horticulture, floriculture, arboriculture, &c.

Department C.—Live Stock.—Domestic and Wild Animals (Classes 172 to 217).—Group 27, horses, asses, mules; Group 28, cattle; Group 29, sheep; Group 30, goats, llamas, camels, and other domestic animals; Group 31, swine; Group 32, dogs; Group 33, cats, ferrets, rabbits, &c.; Group 34, poultry and birds; Group 36, wild animals.

Department D.—Fish, Fisheries, Fish Products and Apparatus for Fishing. (Classes 218 to 268).—Group 37, fish and other forms of aquatic life; Group 38, sea fishing and angling; Group 49, products of the fisheries and their manipulation; Group 41, fish culture.

Department E.—Mines, Mining, and Metallurgy (Classes 269 to 397).—Group 42, minerals, ores, and native metals; Group 43, building stones and quarry products; Group 44, metallic fuels; Group 45, grinding and polishing substances; Group 46, graphite, clays, asbestos, &c.; Group 47, limestone, cements, and artificial stone; Group 48, miscellaneous useful minerals and compounds; Group 49, metallurgy of iron and steel, and their products; Group 50, aluminium and its alloys; Group 51, copper and its alloys; Group 52, placer, hydraulic, and drift mining; Group 53, quarrying and working stone; Group 54, tools and appliances for underground mining; Group 55, boring and drilling mining machinery; Group 56, pumping, draining and hoisting mine machinery; Group 57, moving, storing, and delivering ores, &c.;

Group 58, apparatus for crushing and pulverising; Group 59, sizing appliances; Group 60, extraction of gold and silver by milling; Group 61, extraction of gold and silver by lixiviation; Group 62, extraction of gold, silver, and lead by fire; Group 63, metallurgy of tin, tin-plate, &c.; Group 64, metallurgy of zinc, nickel, cobalt; Group 65, metallurgy of antimony, and other metals not specifically classed; Group 66, assaying apparatus; Group 67, history and literature of mining and metallurgy.

Department F.—Machinery (Classes 398 to 474).—Group 68, motors and apparatus for the generation and transmission of power, hydraulic and pneumatic apparatus; Group 69, fire-engines and apparatus; Group 70, machine tools and machines for working metals; Group 71, machinery for the manufacture of textile fabrics and clothing; Group 72, machines for working wood; Group 73, machines and apparatus for type setting, printing, stamping, embossing, and for making books and paper working; Group 74, lithography, zincography, and colour printing; Group 75, photo-mechanical and other mechanical processes of illustrating; Group 76, miscellaneous hand tools, &c., used in various arts; Group 77, machines for working stone, clay, and other minerals; Group 78, electric welding, forging, &c.

Department G.—Transportation: railways, vessels, vehicles (Classes 475 to 518).—Group 79, railway plant and equipment; Group 80, cable transportation; Group 81, electric railways; Group 82, transportation on common roads; Group 83, aerial, pneumatic, and other forms of transportation; Group 84, marine, lake and river transportation; Group 85, vessels of war and of defence.

Department H.—Manufactures (Classes 519 to 717).—Group 86, chemical products; Group 87, paints, colours, and varnishes; Group 88, type writers and stationery; Group 89, upholstery and interior decoration; Group 90, ceramics; Group 91, tiles, mosaics, and tesseræ; Group 92, art metal work; Group 93, glass and glassware; Group 94, stained glass; Group 95, art carving; Group 96, gold and silver ware; Group 97, jewellery; Group 98, horology; Group 99, silk and silk fabrics; Group 100, fabrics of vegetable and mineral fibres; Group 101, yarns of woven goods, cotton, linen, &c.; Group 102, woven and felted goods of wool and mixtures of wool; Group 103, clothing and costumes; Group 104, furs and fur clothing, &c.; Group 105, laces, embroideries, &c.; Group 106, accessories to the toilette; Group 107, travelling equipments; Group 108, rubber goods, &c.: Group 109, toys; Group 110, leather; Group 111, scales; Group 112, war material; Group 113, lighting apparatus; Group 114, heating and cooking apparatus; Group 115, refrigerators, hollow metal ware, &c.; Group 116, wire and perforated metal goods; Group 117, iron gates, railings, &c.; Group 118, safes, hard ware, cutlery, &c.

Department J.—Electricity (Classes 718 to 769).—Group 119, apparatus to illustrate the phenomena and laws of electricity and magnetism; Group 120, thermo-electric batteries; Group 121, secondary batteries; Group 122, dynamos, &c.; Group 123, transmission and regulation of the electric current; Group 124, electric motors; Group 125, electric lighting; Group 126, electric heating; Group 127, electro-metallurgy; Group 128, electric forging, &c.; Group 129, the electric telegraph; Group 130, the telephone; Group 131, the phonograph; Group 132, surgical electricity; Group 133, miscellaneous applications of electricity; Group 134, history and statistics of electrical invention.

Department K.—Fine Arts: pictorial, plastic, and decorative (Classes 770 to 773). —Group 135, sculpture; Group 136, paintings in oil; Group 137, paintings in water colours; Group 138, paintings on ivory, porcelain, &c., frescoes; Group 139, engraving and etchings; Group 140, crayon and other drawings; Group 141, antique and artistic carving; Group 142, exhibits of private collections.

Department L.—Liberal Arts: education, literature, engineering, public works, music, and the drama (Classes 774 to 881).—Group 143, hygiene; Group 144, instruments and apparatus of medicine, surgery, &c.; Group 145, primary, secondary, and superior education; Group 146, books, journalism, &c.; Group 147, instruments of precision, &c., photography; Group 148, civil engineering and architecture; Group 149, government and law; Group 150, commerce, trade, and banking; Group 151, institutions and organisations for the increase and diffusion of knowledge; Group 152, social, industrial, and co-operative associations; Group 153, religious organisations and systems; Group 154, music and musical instrumants, the theatre.

Department M.—Ethnology, archæology, progress of labour, and invention (Classes 889 to 917).—This department has been so fully referred to in another part of the present paper, and has so little to do with the com-

mercial aspect of the Exposition, that it may be dismissed with the remark that it comprises Groups 155 to 172.

XXVI.—Cost of the Exhibition.

Although forming no essential part in the purpose of this paper, a few words may be added here on the subject of the estimated cost of the Columbian Exposition, its buildings and grounds, its organisation and working expenses. I have stated the total estimated cost of the principal buildings, but it is almost certain that this amount will be largely exceeded, partly because it is in the nature of estimates to fall short of actual expenditure, and partly because additions and alterations, yet unforseen, will surely be made in the Exhibition project. Some allowance indeed has been included for extra cost, and the Ground and Buildings Committee assume that the total outlay in their department will be, in round figures, £1,500,000. But even if this increased figure should prove sufficient, which is doubtful, it will not represent one half of the total amount necessary to carry the enterprise to a conclusion. Below is the most recent estimate given by the Grounds and Buildings Committee of the total expenses of the Exhibition, though it is evident that this estimate does not include a number of grants, subsidies, and other items :—

	£
Grading, filling, &c.	90,000
Landscape gardening	64,700
Viaducts and bridges	25,000
Piers	14,000
Waterway improvements	45,000
Railways	100,000
Steam plant	130,000
Electricity	300,000
Statuary on buildings	20,000
Vases, lamps, and posts	10,000
Seating	1,600
Water supply, sewerage, &c.	120,000
Improvement in Lake front	40,000
World's Congress Auxiliary	40,000
Construction Department	104,000
rganisation and Administration.	662,000
Operating expenses	310,000
Total	£2,076,300

Adding this to the estimated amount for buildings, the total sum required according to this statement is no less than £3,576,000. It will be interesting at a future date to compare this statement with the actual expenditure incurred at the Exhibition. This enormous sum will be raised in several ways; by a small Government grant, at present intended only for Government buildings and organisation; by subscriptions from the City of Chicago; by the entrance money, and by the amounts obtained from the sale of concessions and other privileges granted to contractors and exhibitors.

The available resources, according to the report of the Grounds and Buildings Committee referred to above, are in round numbers as follows :—

	£
Stock subscriptions	1,121,000
City of Chicago Bonds	1,000,000
Estimated gate receipts	2,000,000
Concessions and privileges	300,000
Salvage	200,000
Interest on deposits	6,000
Total	£4,627,000

To the resources above mentioned, have to be added the Government grant, and future subscriptions to stock. Such subscriptions are constantly being made, and although it is impossible to estimate what the total will be, it is confidently expected that the amount will be very large. A call of 60 per cent. has been made on the subscriptions already received, and over £600,000 have been paid in on this account, from more than 30,000 subscribers. Up to a recent date a delinquency of between 7 and 8 per cent. among the subscribers has been recorded; on the other hand a considerable number has paid up calls in full. There appears to be no doubt that the one million sterling to be obtained from the City of Chicago bonds will be realised without difficulty. Of course, the receipts from entries and concessions can only be estimated, but he amounts set down in the report appear reasonable; as regards the former, the two millions anticipated, seem to be based on a total of twenty millions of visitors, unless the present intention of charging two shillings entrance be modified. It is clear, however, before these amounts could be realised, that the Exhibition must be completed and opened, and some arrangements will have to be made to obtain advances on security of the gate money. We all remember how successfully this was done at the Paris Exhibition of 1889, but the process then adopted is entirely out of harmony with American methods, and the present intention is to obtain from the Government the necessary advances.

XXVII.—CONCLUSION.

I hope I have made it clear that the pre-eminence of the Columbian Exposition may be fairly claimed by its organisers, not only because it will be far larger than any international exhibition that has preceded it—that is simply a law of natural development—but because of the real beauty and grandeur of its buildings, and, I think, because of the greater variety, novelty, and interest of its contents. The development of industry in the United States has advanced at such a prodigious rate of late years, that no one can form even a faint idea of its present condition, except by facts and figures, than which nothing is more misleading. Last year I ventured to suggest several reasons why this Exhibition should be truly International, and to-day I find no reason to modify the opinions I then expressed. On the contrary, many significant facts combine to prove the correctness of those views, and that they were not overstated, at all events, so far as this country is concerned. There is a very general feeling of resentment against the United States, because she surrounds her industries with a high barrier of tariffs. Nothing could be more unreasonable than this resentment; it is the business of every country to guard its welfare in the way which seems best to itself, whether by great armies, powerful navies, or internal policy. And, in spite of all the impediments placed in the way of our industrials, no less than one-sixth of our total exports find their way through the protected ports of North America. This vast volume of trade is carried on to the mutual benefit of sellers on this side, and of buyers on the other side, of the Atlantic. It seems to me that among these great interests involved, there would be enough to occupy all the space that has been assigned to us at the Exhibition. Again, we have many special industries, the products of which are of the luxurious and costly kind, to acquire which is the privilege of wealth; and there is no country in the world that can compare with the United States in the number and capacity of such purchasers. This should prove a sufficient inducement to many manufacturers who may become exhibitors at Chicago, with every reasonable certainty of selling all that they may send, and of establishing permanent and profitable connections in the future. Americans are rapidly becoming leading patrons of art. The fact that most art students from the United States go to Paris to study, is probably the reason why the French school controls the American market. It is time that this condition of things is changed; and there is little doubt that it will be changed, if English artists respond to the invitation to exhibit, and are fitly represented in the noble Gallery of Fine Arts that will form so conspicuous a figure at the Chicago Exhibition. English sentiments still remain deeply implanted in American nature, and will respond freely to the feelings expressed by the noble English school, which won so much admiration and surprise at the Paris Exhibition of 1889.

I have pointed out that it is the avowed intention, in American official quarters, to make a bold stroke at our South American trade, and to wrest from us as much of our commerce in the western southern hemisphere, and elsewhere, as may be possible. Being forewarned of this approaching struggle, which is without unfairness and without bitterness, our manufacturers should be forearmed, and, by carrying the war into our commercial enemies' camp, should turn the Exhibition to their advantage, and prove to all the world the incontestible superiority of the goods which we export, both as regards quality and price. Whatever benefits the United States may derive from the policy of high tariffs, it is certain that such complete protection must act prejudicially on many industries, both as regards the quality of goods produced and the cost of producing them. This is an inevitable consequence of the absence of the healthy stimulus of competition. When, therefore, foreign purchasers have an opportunity of comparing at Chicago the relative values of our own goods side by side with similar articles made in the United States, I think there need be little fear of the result. Of course, this has not a universal application; we cannot expect to hold the lead in every branch of manufacture, and it must be frankly admitted—and admitted, I hope, with due admiration of American ingenuity, skill, and enterprise—that in many things the United States has left us far behind. Any attempt at competition in those directions would, of course, be useless, and only lead to disappointment and loss of money.

Another important inducement to manufacturers to be present at Chicago must not be lost sight of. The number of Americans visiting Europe increases year by year; for the most part they are wealthy and leave large sums of money behind them, and, fortunately for our trade, England is rising in favour with these

visitors. Many shopkeepers and manufacturers enjoy great support from American customers, and it would be bad policy for them to neglect the means which will be afforded them in 1893 for increasing this support and making new connections. Exhibitors of such goods as the wealthy American tourist loves to buy, will be remembered long after the Exhibition has been closed, and will be sought for in England by visitors who will remember their displays at the Exhibition.

To the horticulturist, the coming Exhibition affords the certainty of a rich harvest, for as it has already been pointed out, our preeminence in flower culture is undisputed, and this branch of industry is less hampered by tariff obstacles than most others.

Much machinery of varied classes may be exhibited with profit, chiefly for the benefit of foreign customers, but in some cases also to meet the demands of the American market. A large exhibit of objects connected with transportation—such as railway rolling stock and ship models—may be confidently expected; these would be shown, not with the expectation of any actual trade benefit, but for the information of Americans who sooner or later will visit Europe. With a more direct purpose, the manufacturers of bicycles and tricycles may be expected to attend, for they represent a very important industry, in which this country takes an undoubted lead. Patentees of machinery and of processes may, if their exhibits possess real merit, fairly hope to do business in the United States, and our most advanced steam-engine practice will certainly be represented there on a large scale. Altogether, one way and another, we may fairly hope that the area allotted to us in the Machinery Hall will be filled with representative exhibits, and that the displays in the Electricity and Minings Building will not be unworthy of the country. As regards agricultural exhibits, American manufacturers have taken so decided a lead in the implement trade, that there appears but a slender chance for the British exhibitor in America; but the classification in this department is so wide and varied that it embraces many objects in which we can be represented with profit; especially this is the case with live stock for breeding purposes, for which there is always a demand in the United States, and an exemption from duty.

To urge manufacturers to incur the trouble and expense of exhibiting at the Chicago Exhibition, on the merely sentimental ground of aiding in the triumph of a great work, would be absurd, although there are idealists on both sides of the Atlantic who see in the general advancement of humanity, sufficient reason for demanding on the part of others large pecuniary sacrifices. But an Exhibition can only be successful as a commercial enterprise, and any manufacturer would be as foolish to participate without reasonable prospect of benefit, as he would be to abstain from mere prejudice against the tariff. Let our manufacturers consider therefore carefully before deciding; they can obtain sufficient data from which to form a fair appreciation of the chances of profit or loss, and if the odds are in favour of the former, they may go to Chicago, certain of a reception such as they have never experienced before at any International Exhibition; a reception based on true generosity and friendship, from a nation speaking their own language, bound to them by ties of kinship, and by community of sentiment; competitors only so far as competition is inseparable in the struggle for preeminence.

DISCUSSION.

The CHAIRMAN said he expressed the hope, when he presided on the occasion of Mr. Dredge's former paper, that it would be followed by others at periodical intervals, giving further information on the same subject, and every one must have been gratified at the admirable manner in which that hope had been fulfilled. Mr. Dredge and Sir Henry Trueman Wood recently visited Chicago officially on behalf of the Royal Commission, and either of those gentlemen would be only too glad to afford further information on any point of detail to anyone who was interested. He was very pleased to see Mr. Higinbotham, one of the Chicago Executive, present, and hoped he would have something to communicate to the meeting.

Mr. HIGINBOTHAM said he had only just arrived in London, but had been captured that afternoon, and taken to the meeting. He would first refer to what had been said by Mr. Dredge with regard to the high buildings in Chicago, and the contemplated legislation with regard to them. The fact was that the central portion, or heart of Chicago, occupied about half a mile square, and into that space everyone in business wanted to get; it was bounded by the lake on one side, by the river on two others, and on the fourth by an immense system of railways, so that it could not expand, and that had led to the erection of these high buildings. He had calculated that if the whole of that space were covered with such buildings, taking thirteen which already existed as a basis, the number of people employed in that small area would be 1,400,000. That was obviously im-

possible; the people could not come and go, not even if the streets were double-decked, as had been suggested. With regard to the McKinley Tariff, he might say that the mercantile house to which he belonged, which imported as largely as any house in America, had not diminished its imports by reason of the new tariff; on the contrary, they had increased—the people wanted English goods, and would have them at any price. He continued:—Since the visit of your esteemed citizens, Sir Henry Wood and Mr. James Dredge, to our country, the great Exposition has assumed more definite shape as well as vaster proportions. The very valuable information given us by your honourable Commissioners has been of incalculable value to our enterprise, and has placed us under obligations to them as well as to your Government and people. We all feel very deeply the debt we owe for this assistance. It will serve to bring us into closer and, if possible, more friendly relations. Your artists, as well as your dealers in art, will find in our great and rapidly developing country a rich field well worth their cultivation. Your manufacturers are already well informed as to the present situation with us, and are alive to the necessity of keeping abreast of the growth of that vast Empire which our older neighbour—New York, recognizes as the Empire west of the Alleghanies. It is to-day the richest and most rapidly growing section of our country, if not of the world, and is worthy the best attention of all countries desirous of extending their commercial relations. Within a radius of 500 miles of Chicago may be found over 20,000,000 of people, or just about one-third of the population of the United States. The rapidly increasing wealth of our country has, doubtless, been brought to your notice, and I ask your pardon for stating that within the last twenty years the wealth of the United States has grown from about 43 billion dollars to over 63 billion dollars, an increase, I think, that is without a parallel in the history of the world. And when I tell you that in her agricultural and mineral resources only a small per-centage of the possible has been reached, you will not wonder that I do not hesitate to call your attention to the present state and magnificent possibilities of my native land, and particularly that portion of which my own city is the very heart and centre. Being yet a young man, perhaps you will best appreciate what I have said, when I tell you that, within a few miles of Chicago, I was born on a farm the farther side of which was the border line of a rude civilization—all beyond was one vast unbroken wilderness, only inhabited by wild animals and American Indians. Slumbering in the great valley of the Mississippi were the possibilities of a mighty empire that to-day is being felt throughout the world. The product of this valley supplies food to the nations of the earth, and here myriad homes are being established by honest toilers, that come to us from the more densely populated countries of the old world. Your own country has given us very many of our strongest and cleverest men. Countless numbers of our most thrifty citizens look to this land as their first love. Your interest in them and theirs in you serves as a bond between the two greatest nations in existence. Chicago is, as you know, the commercial centre of this rich section. From it radiate more arteries of trade than from any other commercial centre. As was said of an ancient city, so it may be said of Chicago, that all roads lead to Chicago. Do you wonder that we there wish, for manifold reasons, to produce a magnificent Exposition? Chiefest of these is a desire to give our people an opportunity to see that which a great majority of them could never see if it is not brought near to them. We are willing to spend a large amount of money and years of our lives, that our people may reap the benefit that such an Exposition will give. In joining us in producing this great Fair you are helping your own loved ones who have made homes with us, and become prominent factors in our social fabric, while they are prosperous and happy in the homes that dot the land. We can, by the medium of the Exposition, enable them to build a better, stronger, and more enduring civilisation than that which they now enjoy. If, in helping our people to rise to a higher plane, we enable them to become more liberal patrons of art, and larger consumers of your manufactures, we not only help them, but your own working people, as well as the manufacturers who employ them. If, perchance, a slight benefit shall thereby accrue to our city we shall be content. I presume the Commission recently sent to your city from our country has given you sufficient in the line of statistics relative to our Exposition. I trust you will pardon me if I say that, just before leaving home, I was one of a sub-committee of our Finance Committee to ascertain the cost of the Exposition. I will not weary you with details, but content myself with giving you the totals:—

Cost of grounds and buildings to May, 1, 1893	$13,000,000
Cost of Administration to May, 1, 1893	3,000,000
Cost of Administration after May 1, 1893	3,000,000
Cost of construction after May 1, 1893	2,000,000
	$21,000,000

This does not include the appropriations of foreign Governments, neither are included the sums appropriated by our own general and State Governments, which will swell the grand total to about 36,000,000 dollars, or £7,000,000. Permit me, in closing, to thank you, and to extend an invitation to come to our feast in 1893, where we will give you a hearty welcome, and endeavour to care for you kindly.

Mr. C. M. Kennedy, C.B., said the Royal Commission fully recognised the great services rendered by

Sir Henry Wood and Mr. Dredge, in going to the States to obtain the information which, through the Commission, was given to the public. The great meeting of the nations in 1893 would be attended by visitors from all parts of the world, and it was of the greatest importance to British commerce that those visitors from the far East, and Central and South America, should carry away with them a correct impression; but this could not be done unless there were a good representative display of English goods. The Royal Commission were proceeding by means of committees of advice, through whose means they hoped to be brought in contact with all branches of industry, and it would then be for the various individuals and firms to consider how far it would be to their advantage to be represented at the Exhibition. In many branches of trade Great Britain had at present command of the market, and that command ought to be retained. This was not only to the advantage of English capitalists and manufacturers, but in an even greater degree to that of the workpeople whom they employed. The Royal Commission would afford all the information in their power to any parties interested. We were engaged in a friendly rivalry with the United States in many branches of trade, and we should therefore take full advantage of the opportunity now offered.

Mr. R. S. McCormick said—I must thank you for the honour which you have conferred upon me, as the representative of the Columbian Exposition, in electing me to membership of this Society, upon whose roll are to be found the names of the men who have done most to place England in the foremost place which she holds in Art-Industries and Commerce, not omitting the name of my own great countryman, Benjamin Franklin. I must also express the pleasure which the appointment of the Council of the Society of Arts, with the consent of H.R.H. the Prince of Wales, your President, as a Royal Commission, gave to the Executive in Chicago, and the Commission appointed by the President to represent the United States Government, in matters pertaining to the Exposition, this appointment being a guarantee that Great Britain will take the prominent place in the Exposition worthy of her history and her place among the nations of the earth. Those who are disposed to complain bitterly of the effect of the McKinley tariff have entirely overlooked the fact, that of all the customers of Great Britain the United States is *facile princeps*, notwithstanding the tariff which is called hostile, though only a fair offset to your cheaper labour, cheaper money, and heavily subsidised steamship lines. The following is a list of England's twelve best customers, with the amounts taken by them, for the three quarters ending September 30th, 1891:—

United States	£21,448,747
Germany	14,494,312
France	12,127,706
Turkish Dominions..	£8,819,006
Holland	7,125,185
Brazil	6,529,071
Belgium	5,553,261
Italy	4,994,227
China, exclusive of Hong Kong ..	4,932,318
Russia	4,243,753
Spain..	3,887,365
Argentine Republic, including the Atlantic Coast of Patagonia ..	3,431,938

To the value of manufactured articles taken by the United States from Great Britain during the twelve months just elapsed, must be added the railway stock and securities of every kind which a financial storm compelled English holders to find a quick market for, and the United States was the only country able and willing to put a shoulder under this load. With a choice of a quick market for these securities, or narrowing of the market for your manufactures, is there any doubt as to what the choice would have been? It is now only necessary for me to express my own appreciation of the able paper which Mr. Dredge has just read. In Chicago he is looked upon as one of our own people, and we deeply appreciate the services he has already rendered to the Exposition, and the never-tiring zeal with which he seems determined to make it impossible for appreciation to keep up with obligation.

Mr. Lee Bapty, having spent a short time in Chicago last summer, said he soon recognised the wisdom of the choice of that city as the site of the Columbian Exhibition, even in preference to New York. He was very pleased to hear from Mr. Higinbotham, whose store in Chicago he well remembered, that notwithstanding the McKinley tariff, the exports from this country to the United States had increased. There were certainly one or two branches of business in which he understood the tariff was prohibitive; but he believed they were very very few and unimportant compared to the general trade.

Mr. Collins Levey, C.M.G., did not think there ought to be any difficulty in filling the space allotted to England at the Exhibition, considering our enormous trade with the States, and the fact that as much space was recently occupied at the Melbourne Exhibition by the colony. There were one or two points, however, on which he was sure intending exhibitors would be glad to be reassured. One was with regard to the patent laws; that new inventions should not be pirated if they were not patented in America. Another was in regard to the Customs. At the Centennial Exhibition he found every facility afforded by the officials at Philadelphia, but in New York there were great difficulties, and on more than one occasion he had to appeal to Washington before he could put the New York Customs officials in operation; on the present occasion there would probably

till be some little friction between New York and Chicago, and special precautions ought therefore to be taken. Lastly, he feared there would be some difficulty with regard to the American law forbidding the importation of contract labourers, which he understood was very strictly enforced, and would affect *employés* engaged at the Exhibition.

Mr. McCormick said he could assure the meeting that exhibitors of new inventions would be fully protected, and with regard to the last point, the Attorney-General of the United States had expressed the opinion that the *employés* of exhibitors, or persons in charge of exhibits, would be entirely exempt from the contract labour law. There would be no trouble at the Custom-house, as the goods would go in bond through New York, being taken from the ship direct to a freight car, which would deliver them in the grounds of the Exhibition, which would be practically a bonded warehouse during its continuance If he mistook not, this information had already been published.

Mr. G. N. Hooper congratulated the United States on having obtained the co-operation of the British Government, which would add greatly to the facilities for exhibition, and induce many to send who would otherwise have held aloof. At the recent exhibition in Spain, for want of the protection of the British Government, the space allotted to this country was only half occupied, and the exhibitors were placed at a considerable disadvantage compared with their foreign competitors. As a member of the London Chamber of Commerce, he had the opportunity of meeting the Commissioners who came from Chicago, bringing information and cordial invitations, and was very pleased to think that the Chamber of Commerce promised them its sympathy and support. Having visited Chicago within the last few years, he could endorse what had been said as to the magnificence of the city and the comfort of the hotels, and he would especially call attention to the luxurious accomodation provided on the railways, which rendered the journey from New York to Chicago, though it took about twenty-four hours, anything but tedious. You could sleep six or seven hours, obtain refreshments as easily as in a good hotel, and read or write with the greatest convenience; so that you arrived at your destination quite ready for the business or pleasure which awaited you. If the weather was hot, the cars were well ventilated, and if cold, they were warmed.

Mr. Dredge, in reply, said he was very pleased that Mr. Higinbotham had arrived in time to make such a useful supplement to his paper; he was essentially a representative Chicago man, but there were thousands like him, and that accounted for the prosperity of the city. Mr. McCormick had spoken of him in too flattering terms, but he must admit that he had only echoed what he had often heard on the other side of the water. It was gratifying to find a man of Mr. Lee Bapty's experience in such matters endorsing his view that Chicago was the best place in which to hold the Exhibition; and he could corroborate what Mr. McCormick had said in reply to Mr. Collins Levey.

The Chairman then moved a vote of thanks to Mr. Dredge, which was carried unanimously.

Miscellaneous.

VIENNA MUSICAL AND DRAMATIC EXHIBITION, 1892.

An International Musical and Dramatic Exhibition will be held at Vienna from the 7th May to 9th October, 1892.

The Exhibition will be held in the Rotunda and the surrounding gardens situated in the Prater, and will be divided into two sections, the first comprising a division illustrating the historical, artistic and technical development of all appliances connected with music and the drama. The second section to consist of a special Trades Exhibition, which will comprise all the productions of modern industry relating to the cultivation of music and the drama.

The scheme of the Exhibition is arranged as follows:—

A. *Memorable Biographical Events.*—Relics and objects of interest connected with celebrated musicians, dramatic authors and artists (past and present) associated with the opera, drama and ballet, such as pictures (paintings, engravings, photographs, &c.), autographs and medals, &c.

B. *Music.*—1. Instruments. Historical development of musical instruments up to the present day:—(*a*) Keyed instruments; (*b*) String instruments; (*c*) Wind instruments of wood and metal; (*d*) Instruments played by striking; (*e*) Various other instruments, viz: harmonicons, wood and reed instruments, chime clocks, orchestrions and the like; (*f*) Aids to performing music, such as tuning forks, metronomes, &c. 2. Graphic representation of music:—(*a*) Manuscript music showing the ancient style of copying the notes; (*b*) ancient musical printing, with characteristic examples of every period; (*c*) modern musical printing, from the first editions of Bach and Händel up to the present time. 3. Musical literature and instruction.—(*a*) Literature of the past and present: history of musical works and compositions. (*b*) Instruction. (1) Theoretical and practical works; (2) statutes and annual reports of musical schools and conservatoires.

C. *Theatre.*—Theatrical conditions of the past and present time—(1) theatre-building; (2) adjuncts to theatrical representations, decorations, theatrical

properties, costumes, &c.; (3) pictorial representation of theatrical exhibitions, sculpture, &c.; (4) dramatic works of all descriptions, including the libretti of operas, and ballet subjects; (5) scenic science, theatrical literature and critiques.

D. All home and foreign objects of interest coming under the above heads.

Musical and theatrical performances, particularly from the historical, national, and ethnological point of view, will be given during the Exhibition.

Applications for space should be made to the Committee, 11, Eschenbachgasse, Vienna, not later than 31st December, 1891.

NOTES AND HINTS ON THE VEGETABLE PRODUCTS OF TROPICAL AFRICA.

By John R. Jackson.

[Continued from page 62.]

Gum Euphorbium.—The milky juice of several species of *Euphorbia* solidify on exposure to the air. Some interest has of late years been attached to these juices for the purpose of mixing with rubber and gutta-percha, as well as for the manufacture of an anti-corrosive paint for ships' bottoms. The gum has been brought into England from St. Paul de Loanda and from Natal. Attention should be given to the juices of any species of *Euphorbia.*

Food Products.—There is probably not much to be done in the way of new fruits from tropical Africa. Any native edible fruits, however, which seem to have any points to recommend them, should be carefully collected and sent home, together with branches of the plant furnishing them, and flowers, if possible. Attention should also be paid to tuberous or edible roots, and, indeed, all products of an edible character. The "manioc," "mandioc," or "cassava" (*Manihot utilissima*), is cultivated in west tropical Africa for its large fleshy roots, from which tapioca is made. This plant might be worth extended cultivation for the preparation and exportation of tapioca.

Drugs.—A very large field is open in the discovery of new drugs. Any plant said to have medicinal properties, or to be used for any special complaint or disease by the natives, should be carefully collected, in every case with the flowers, and, if possible, the fruit also. A sufficient quantity of the part of the plant used, such as bark, root, wood, fruit, or foliage, should be sent home for experiment and trial.

The natural orders that are well known to yield valuable medicines should be carefully examined. Thus, any plants of the Rubiaceæ which furnishes cinchona bark, might be tested for bitter tonic, but wholsome properties; the Malvaceæ, or mallow family, for mucilaginous or demulcent properties; the Euphorbiacæ, for cathartic properties, and so on.

The kola nut (*Cola acuminata*) is perhaps one of the best-known medicinal plants of west tropical Africa. The tree grows to a height of about 40 feet, and its cultivation has spread of late years to central Africa, as well as to the African shores of the Mediterranean. It has also been introduced for cultivation into India, Ceylon, West Indies, Mauritius, Zanzibar, and other countries. Quite recently a demand has sprung up in the English markets for kola nuts; and a few months since they were quoted at about 2s. 6d. per pound, but have since declined to 3d. or 4d. wholesale.

The ordeal bean of Old Calabar, (*Physostigma venenosum*) is a perennial climber, with a woody stem some 50 feet high, growing near the mouths of the Niger and old Calabar river. The seeds, known as Calabar beans, contain an active principle, used in European practice in ophthalmic cases, as well as in tetanus and neuralgic affections. The plants might be worth cultivation. The beans fetch about 4½d. per lb.

Doundaké (*Sarcocephalus esculentus*).—This is a West African tree, belonging to the same order as the cinchonas (Rubiaceæ). It has attracted some attention in Europe since 1885, on account of its tonic and febrifugal properties. The fruit is edible, and is known as the Sierra Leone peach. The golden yellow colour might be turned to account as a dye.

Strophanthus, or Kombe.—Under these names the seeds of *Strophanthus hispidus*, and probably of several other species at present but vaguely known, have become very important medicines in European practice, possessing valuable cardiac properties. Considering the doubt attached to the determination of the scientific names of the several forms or species now brought into commerce, much care should be taken in collecting the leaves, flowers, and fruits of every form, and carefully marking them, so that on their arrival in England they may be accurately matched and determined. For commercial purposes, the fruits or follicles should not be gathered before they are ripe, as the seeds, being immature, shrivel in drying, and consequently lose some of their active principle. The seeds should not be extracted from the follicle, as they keep fresher by being left in the fruit. As *Strophanthus hispidus* is the most valuable of the species at present known, this particular plant should be carefully looked after, so as to ensure the highest return.

Cardamoms, the dried fruit of *Elettaria Cardamomum*, a product chiefly of Southern India, are always in demand, and the plant would be worth introducing into West Africa.

Vanilla.—This well-known and valuable article is the carefully dried fruit of *Vanilla planifolia*, one of the very few orchids that possess any economic value.

Its cultivation has never assumed any important position in any British colony. The plant would no doubt thrive in Western Africa. As medicinal plants of minor importance are very numerous in Western Africa, it would be impossible to enumerate them here. Many valuable hints on this subject may be obtained from the List of Economic Plants

of Western Africa, at p. 269 of Moloney's "Sketch of the Forestry of West Africa," published by Samson, Low and Marston.

Since the paragraph on "Lagos Rubber," published on p. 62 of last week's *Journal*, was written, further material has come to hand, which shows that, at present at least, there is little or no prospect of this particular kind of rubber becoming a commercial article.

[To be continued.]

Correspondence.

SECONDARY BATTERIES.

Mr. W. H. PATCHELL has sent the following correction of the first portion of his remarks:—"He believed the Correns grid was one of those seized by the German Government, and turned out of the Frankfort Exhibition, as it was thought to be an infringement of the Electrical Power Storage Company's Patent, held in Germany by the Tudor Company: it was really Mr. Sellon's grid, and was now used for the negative in the Electrical Power Storage Company's high-discharge type cells. The ribs in the Tudor plates, both positive and negative, were horizontal. In the Electrical Power Storage Company's high-discharge cell, the positive was practically the same as the Tudor, but the negative was the same as the No. 4 grid, which gave a perfect negative, as far as he knew at present. As mentioned by Mr. King last winter, the paste in the negative plates, when some eighteen months or two years old, began to show signs of shrinking, and, with the ordinary form of square pellet, would loose contact with the grid, but, with the lattice grid, the more it shrank the tighter it became."

General Notes.

INTERNATIONAL CONGRESS OF ELECTRICITY.—The subject of an International Congress of Electricity, to be held at Chicago, in connection with the World's Fair, continues to attract much attention in America. A report about the matter has been presented to the Director-General of the Exhibition by Mr. J. Allen Hornsby, Secretary of the Department of Electricity. During a recent visit to Europe, Mr. Hornsby discussed the question with several leading men of science in England and on the Continent; and he was encouraged by them to believe that, if certain conditions were complied with, the success of the Congress would be certain. They all agreed that the Congress should be held under the auspices of the United States Government. Invitations, they thought, should be issued by the Government to individual scientific men through the Governments of the countries to which the individuals belong. "This course of action," says Mr. Hornsby, "in the opinion of the authorities whom I consulted, will ensure an official character to the proceedings of the Scientific Congress, and will virtually pledge the various Governments to a recognition and adoption of the standards created."—*Nature.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 16.—GENERAL PITT RIVERS, "Typological Museums, as exemplified by the Pitt Rivers Museum at Oxford." PROFESSOR FLOWER, C.B., Director of the Natural History Museum, will preside.

Papers for meetings after Christmas:—

"Spontaneous Ignition of Coal, and its Prevention." By PROF. VIVIAN B. LEWES.

"Burning Oils for Lighthouses and Lightships." By E. PRICE EDWARDS.

"Dust, and How to Shut it Out." By T. PRIDGIN TEALE.

"Iceland." By T. ANDERSON.

"Ancient and Modern Art Pottery of Japan." By ERNEST HART.

"Artistic Treatment of Jewellery: The Jewel and Address Caskets." By I. WILLIAM TONKS.

"Agricultural Banks for India." By SIR WILLIAM WEDDERBURN, Bart.

"The Scientific Value of Lovibond's Tintometer." By F. W. EDRIDGE-GREEN, M.D.

"The Agricultural Needs of India." By DR. J. AUGUSTUS VOELCKER.

"Travels in Indo-China." By LORD LAMINGTON.

"The Woodcuts of Gothic Books." By WILLIAM MORRIS, M.A.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By CAPTAIN W. LOVETT CAMERON, R.N., C.B.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays at Half-past Four o'clock and Eight o'clock respectively, notice of which hour will be duly announced:—

January 12, February 16, March 15, April 5, 26, May 24.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at Half-past Four o'clock:—

January 21, February 11, March 3, 24, April 28, May 19.

APPLIED ART SECTION.

The meetings of this Section will take place

on the following Tuesday evenings, at Eight o'clock:—

January 26, February 23, March 8, 29, April 12, May 17.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

A. P. Laurie, M.A., "The Pigments and Vehicles of the Old Masters." Three Lectures.

Lecture III.—December 14.—The mediums used by the Old Masters, in tempera and oil painting. The preparation of the oils and varnishes, and the properties of the same.

Howard Lectures.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by Prof. W. Cawthorne Unwin, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

Juvenile Lectures.

Two lectures, suitable for a juvenile audience, will be delivered by Professor John M. Thomson, Sec. C.S., on the "Three States of Matter: Solid, Liquid, and Gaseous," on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 14....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. A. P. Laurie, "The Pigments and Vehicles of the Old Masters." (Lecture III.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. Townsend, "American Theatres."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. D. Morris, "Tropical Plants and Flowers."

Tuesday, Dec. 15...East India Association, Westminster Town-hall, S.W., 2½ p.m. Dr. G. W. Leitner, "The Races, Religions, and Politics of the Pamir Regions."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Henry Gill's paper, "The Sale of Water by Meter in Berlin."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Charles Booth, "Enumeration and Classification of Paupers and State Pensions for the Aged."

Pathological, 20, Hanover-square, W., 8½ p.m.

Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. Mr. John Laing, "Destructive and Conservative Distillations of Mineral Oils and their molecular condition."

Wednesday, Dec. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. General Pitt Rivers, "Typological Museums, as exemplified by the Pitt Rivers Museum at Oxford."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. William Marriott, "Report on the Thunderstorms of 1888 and 1889." 2. Mr. Frederick J. Brodie, "The Prevalence of Fog in London during the twenty years, 1871-1890."

Microscopical, 20, Hanover-square, W., 8 p.m. The Hon. J. G. P. Vereker, "The Resolution of *Podura*."

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion of the President's Address. 2. Mr. A. V. Newton, "Patent Agency: its Origin and Uses." 3. Messrs. Abel and Loubier, "Notes on the New German Patent-law."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. 1. Mr. E. F. Wailes will reply to the discussion on his paper on "Proposed Improvements in the Construction of the Bottoms of Ships and Steamers." 2. Mr. J. F. Walliker will reply to the discussion on his paper on "Pumping Arrangements, &c., for Steam Vessels." 3. Discussion on Mr. J. Jennings Campbell's paper on "Engines for Ships of War." 4. Paper on "Tonnage Measurement," by Mr. M. C. James.

Inventors' Institute, 27, Chancery-lane, W.C., 4½ p.m. Annual Meeting.

Thursday, Dec. 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. L. C. Miall and Mr. A. R. Hammond, "Development of the head of the Imago of Chironomus." 2. Mr. G. M. Thomson, "Two species of Cumacea in New Zealand."

Chemical, Burlington-house, W., 8 p.m. 1. Miss K. Williams, "The Composition of Cooked Vegetables." 2. Messrs. S. E. Linder and H. Picton, "Some Metallic Hydrosulphides." 3. Mr. Harold Picton, "The Physical Constitution of some Solutions of Insoluble Sulphides." 4. Messrs. H. Picton and S. E. Linder, "Solution and Pseudo-solution." 5. Dr. A. Colefax, "The Changes Proceeding in Acidified Solutions of Sodium Thiosulphate when the Products are Retained within the System," and "The Action of Sulphurous Acid on Flowers of Sulphur." 6. Dr. Matthews, "The A and B Modifications of Chlorobenzene Hexachloride." 7. Drs. Armstrong and Kipping, "Camphrone, a Product of the Action of Dehydrating Agents on Camphor." 8. Dr. Armstrong and Mr. Rossiter, "Studies on the Dibromo Naphthalenes."

London Institution, Finsbury-circus, E.C., 6 p.m. The Dean of Winchester, "Winchester Cathedral."

Historical, 20, Hanover-square, W., 8½ p m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Junior Engineering Society, Westminster-palace-hotel, S.W., 8 p.m. Mr. S. H. Wells, "Engineering Practice in the Cleveland and North-East Coast Districts."

Friday, Dec. 18...Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W. 5 p.m. Mr. H. Kilgowie, "Interference with Alternating Currents."

Correction.—P. 58, col. 2, line 15 from bottom, *for* Elwood *read* Elwell; p. 60, col. 2, lines 13-22 *should be* 2-11.

Journal of the Society of Arts.

No. 2,039. Vol. XL.

FRIDAY, DECEMBER 18, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, by Professor JOHN M. THOMSON, Sec. C.S,, on "Three States of Matter: Solid, Liquid, and Gaseous."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

On Monday evening, 14th inst., Mr. A. P. LAURIE delivered the third and concluding lecture of his course on "The Pigments and Vehicles of the Old Masters," in which he treated of the preparation of oils and varnishes, and of the properties of the latter as preservatives of fugitive pigments.

On the motion of the CHAIRMAN (Prof. W. C. Roberts-Austen, C.B., F.R.S.), a vote of thanks to Mr. Laurie for his valuable and interesting course of lectures was passed.

The first lecture will be printed in the number of the *Journal* for next week.

FOTHERGILL PRIZE.

Under the will of Dr. Fothergill (1821), funds were bequeathed for the offer of Medals for subjects, in the first instance, relating to the Prevention of Fire.

A Society's Gold Medal, or £20, is now offered for the best invention having for its object the Prevention or Extinction of Fires in Theatres or other places of public amusement.

In cases where the invention is in actual use, reference should be made to places where it could be inspected.

A full description of the invention, accompanied by such drawings or models as are necessary for its elucidation, must be sent in on or before the 31st December, 1891, to the Secretary of the Society of Arts, John-street, Adelphi, London.

The Council reserve the right of withholding the prize, in case there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Monday, December 14. Present: The Attorney-General, M.P., in the chair; Sir Frederick Abel, K.C.B , D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, R. Brudenell Carter, F.R.C.S., B. Francis Cobb, Sir Henry Doulton, James Dredge, Francis Elgar, LL.D., Thomas Hawksley, F.R.S., John Biddulph Martin, W. H. Preece, F.R.S., Sir Robert Rawlinson, K.C.B., Prof. W. C. Roberts-Austen, C.B., F.R.S., with Sir Henry Trueman Wood, Secretary.

COMMITTEE ON AGRICULTURE.

The first meeting of this Committee was held on Thursday, 10th inst., in the Council Chamber of the Royal Agricultural Society, at 12, Hanover-square. Present: The Earl of Feversham in the chair; Sir Edward Birkbeck, Bart., M.P., Sir George Macpherson Grant, Bart., Sir Robert Jardine, Bart., M.P., Col. Sir Nigel Kingscote, K.C.B., Sir Jacob Wilson, Lieut.-General J. Michael, C.S.I., Mr. G. Mander Allender, Mr. Richard Bannister, Dr. James Bell, C.B., F.R S., Mr. J. Bowen-Jones, Mr. Ernest Clarke, Major Craigie, Mr. Walter Gilbey, Mr. Charles Howard, Mr. Ralph Palmer, Mr. Clare Sewell Read, Mr. John Thornton, and Mr. Christopher W. Wilson ; with Sir Henry Trueman Wood, Secretary of the Royal Commission.

Mr. Ernest Clarke (Secretary of the Royal Agricultural Society) accepted the office of Hon. Secretary to the Committee.

The Committee considered the Prize Sheet for Live Stock issued by the Chicago Executive, and appointed a Sub-Committee to examine it in detail, with a view to obtaining from the Executive precise information as to any points in the Prize sheet or Regulations which appeared to require explanation or modification.

PROTECTION OF INVENTIONS.

Her Majesty, by Order in Council, has been pleased to declare that the conditions of the Patent Act, 1883, under which an application for a patent is not to be invalidated by the exhibition of an invention at an International Exhibition, are to apply to the Chicago Exhibition; and also that exhibitors are to be relieved from the conditions of the above Act, under which they were required to give notice to the Comptroller of Patents of their intention to exhibit the article afterwards sought to be patented. The regulations also apply to designs intended to be registered.

COLLECTION OF ECONOMIC MINERALS.

The Royal Commission for the Chicago Exhibition are anxious to comply with a request made to them by the Executive Authorities of the Exhibition, that a typical collection of Economic British Minerals may be included in the British Section; and they are now applying to owners and managers of mines, asking for specimens of the principal British minerals. Mr. B. H. Brough, the Instructor in Mine-Surveying at the Royal College of Science, South Kensington, has kindly undertaken to classify and arrange the collection, and any suitable specimens may be addressed to him. What is required is not specimens of special value or rarity, but samples of ordinary ores, &c., so that the collection, when complete, may be fully illustrative of the mineral resources of the kingdom. At the close of the Exhibition the collection will be presented to an American museum.

COLONIAL COMMISSIONERS.

CEYLON.—The Royal Commission have received information that the Government of Ceylon have, with the approval of the Secretary of State for the Colonies, determined to appoint a Special Commissioner to arrange for the representation of Ceylon at the Exposition.

CAPE COLONY.—The Agent-General for the Cape Colony has informed the Royal Commission that the Cape Government have appointed a Special Commissioner to represent the colony at the Exposition, and that Mr. Ludwig Wiener, M.L.A., has been selected for the office.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 16, 1891; PHILIP LUTLEY SCLATER, M.A., Ph.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barrett, Arthur, 114, High-street, Kensington, W.
Foord, Alfred Stanley, Tay-villa, Richmond-gardens, Romford-road, Forest-gate, E.
Hindmarsh, George Lisle, 29, Regent quay, Aberdeen.
Hughes, Thomas W. R., 11, George-lane, Lewisham, S.E.
James, J. H. Cordner, 10, Mansion-house-chambers, 11, Queen Victoria-street, E.C.
Jarman, Captain Stephen, R.N.R., Dartmouth villa, Evering-road, Clapton, N.E., and 19, Birchin-lane, E.C.
Maund, John Oakley, 80, Portland-place, W.
Watney, John, Mercers'-hall, E.C.
Wyon, Allan, 2, Langham-chambers, Portland-place, W.

The following candidates were balloted for and duly elected members of the Society:—

De Winton, Major George, Junior United Service Club, S.W., and South Norwood, S.E.
Parker, Thomas, Newbridge, Wolverhampton.
Sandbach, Captain Arthur Edmund, R.E., A.D.C., care of Messrs. King, King, and Co., Bombay.

The CHAIRMAN, in introducing General Pitt-Rivers, said:—In the absence of my friend Prof. Flower, I have had great pleasure in acceding to the request that I should occupy the chair this evening. General Pitt-Rivers, who is about to address you on this occasion, is well known to us in the region of science as one of our leading authorities on anthropology. The science of man is a comparatively new science, but a very progressive one. One of the eight sections into which the British Association is divided is specially devoted to its advancement, as is also the Anthropological Institute, one of the principal scientific societies of London. No one in England has done more for Anthropology than General Pitt-Rivers.

Having formed a splendid and almost unrivalled collection of objects for the illustration of his favourite science, he has presented it to the University of Oxford. There it is excellently housed in a particular department of the museum, and carefully kept in order by a special curator. No one who has inspected this beautiful collection can be otherwise than impressed with its extent and completeness. In the wilds of Dorset, again, General Pitt-Rivers has founded and stored another museum of somewhat similar character, but, as he will presently explain to you, specially modified for the altered circumstances of the case. This also has been a most successful institution, as you will presently hear. I will say no more, but call upon General Pitt-Rivers to commence his address on Typological Museums, which, I am sure, we shall all listen to with great interest.

The paper read was—

TYPOLOGICAL MUSEUMS, AS EXEMPLIFIED BY THE PITT-RIVERS MUSEUM AT OXFORD, AND HIS PROVINCIAL MUSEUM AT FARNHAM, DORSET.

By Lieut.-General Pitt-Rivers, D.C.L., F.R.S., F.S.A.

Museums may be established for different purposes, and the objects in them should be collected and arranged to further the particular purposes for which they are intended.

Technical museums may be established for instruction in art; to improve the taste of those engaged in manufactures. Of these, the South Kensington Museum, with the origin of which this Society had much to do, may be taken as the type. The National Gallery, in this sense, may be regarded as a museum of painting for the encouragement of artists. In a technical museum, the object is simply to collect specimens, calculated to serve, if not as actual models, at any rate as examples of styles to be imitated: the historical arrangement of them is of secondary importance. Although no doubt the same purpose might be served, and the interest of the museum increased, if they were historically arranged; still it would undoubtedly be proper in a museum instituted for this purpose, that the primary arrangement should be from the standpoint of art. It is not a museum for general educational purposes, as it can never have been contemplated that the whole or the majority of the visitors should qualify as manufacturers or artists; or, if it is efficacious for general education, it is only so in the sense of improving the public taste.

Next we have to consider the purposes to be served by such an establishment as the British Museum. The British Museum was, no doubt, in its origin, pretty much what local museums have hitherto been, a collection of miscellaneous antiquities; some small, others of enormous size. The collections of late years have been enlarged and classified in historical grand divisions or geographical areas, and the additions have been made, as time went on, with more regard to scientific arrangement, in proportion to the advance of knowledge. But it has not been collected from the first upon any system, or with a view to any special purpose; certainly not for educational purposes. It has been necessary to obtain specimens as opportunity offered, and to exhibit them in rooms that are ill-adapted for displaying them historically, designed in subordination to architectural considerations, and not with a view to the best means of arranging the specimens. As a large store of antiquities, it is probably the most useful institution in the world for *savants*, who know what to look for and wish to study them, in order to form their own classifications and deductions. As an educational museum, it is simply bewildering, and although lectures have lately been given upon the collections, such lectures are available only for comparatively few persons, and those not the working classes, who go there to obtain knowledge, by examining the antiquities and forming their own ideas upon what they see. It would be impracticable ever to convert the British Museum into an educational museum. More than half the objects would have to be eliminated, and the apartments altered to suit an educational arrangement. It would spoil the museum for the use of *savants*. I call such a museum a Museum of Reference, or it might, perhaps, more properly be termed, a Museum of Research.

I hold that the great desideratum of our day is an educational museum, in which the visitors may instruct themselves. For good or for evil, it is not here the place to discuss the question, we have thought proper to place power in the hands of the masses. The masses are ignorant, and knowledge is swamped by ignorance. The relative numbers of the educated and uneducated are enough to ensure this. The knowledge they lack is the knowledge of history. This lays them open to the designs of demagogues and agitators, who strive to make them break with the past, and seek the remedies for

existing evils, or the means of future progress, in drastic changes that have not the sanction of experience. It is by a knowledge of history only that such experience can be supplied. It is true that the history of laws, customs and institutions cannot be displayed in museums. You cannot place the successive links of development side by side in such a manner as to appeal to the eye; but the material arts are capable of such an arrangement, and the knowledge acquired in the one branch will be, to some extent, available in the other. The law that Nature makes no jumps, can be taught by the history of mechanical contrivances, in such way as at least to make men cautious how they listen to scatter-brained revolutionary suggestions. The knowledge of the facts of evolution, and of the processes of gradual development, is the one great knowledge that we have to inculcate, whether in natural history or in the arts and institutions of mankind; and this knowledge can be taught by museums, provided they are arranged in such a manner that those who run may read. The working classes have but little time for study; their leisure hours are, and alway must be, comparatively brief. Time and clearness are elements of the very first importance in the matter under consideration. The more intelligent portion of the working classes, though they have but little book learning, are extremely quick in appreciating all mechanical matters, more so even than highly educated men, because they are trained up to them; and this is another reason why the importance of the object-lessons that museums are capable of teaching should be well considered.

For an educational museum originals are not necessary. Casts, reproductions, and models are preferable; the proper specimens can be more easily selected; they are infinitely less costly. Such collections are not dependent on the chance of obtaining what is wanted from original explorers. Museums of casts do not compete with the research museums, in which the originals should be stored. Models occupy less room than originals, and can be more easily arranged to exhibit sequence within a limited space.

In an educational museum, specimens should be selected that are useful in displaying sequence. These should be arranged so as to show how one form has led to another. When there is actual evidence of the dates of the objects, of course the arrangement must be for the most part in the order of dates. But when, as in the case of most prehistoric objects and many of the arts of savage nations, the dates cannot be given, then recourse must be had to the sequence of type, and that is what I term "Typology." It is not an accepted term, and I am not aware that it has been applied before to the study of sequence of the types of the arts. But it appears to me that a name is wanted for this branch of investigation, which the term "Typology" supplies.

If it were taken to imply the study of fixed types as characteristic of particular phases of the arts, it would be erroneous. It includes the growth, varieties, and developments of the several types. It supplies the want of dates by showing how certain forms must have preceded or followed others in the order of their development, or in the sequence of their adoption. It may be said, as a rule, that simple forms have preceded complex ones. Within certain limits this must be true, but it is not always the case, for, in many instances, progress consists in eliminating superfluous complexity, and reducing the expenditure of time and labour. We have in this, as in all mundane affairs, to deal with degeneracy and decay, as well as progressive growth: the two have gone on side by side. It is the work of typology to unravel the true thread of events, and place the objects in their proper sequence for the use of students. Typology forms a tree of progress, and distinguishes the leading shoots from the minor branches. The problems of the naturalist and those of the typologist are analogous. The difficulties are the same in both. In some cases the number of missing links makes it impossible to determine the true succession of forms. In such cases recourse must be had to survivals, as in the case of the majority of savage weapons or forms of art, in which the successive links, being made of wood or perishable materials, have decayed. But a theoretical, and fairly accurate development, may nearly always be traced amongst the arts of savages by objects in present use. When a simple form is suited to its environment, or when its use fulfils common purposes that cannot be better served by its successors, or when economy of labour is a desideratum, the simple form survives; as, for example, in the case of the common door-bolt, which is the father of all kinds of complex door locks, and which is still used upon the same doors as the contrivances that have sprung from it; or in the case of the common hand-made pots that are still baked in an ordinary turf fire in the Hebrides, at the same time as the most skilled

productions of our modern potteries. So in natural history, invertebrate and vertebrate animals and mammalia are all found living side by side in the same localities, although we know that they represent successive stages in the development of species. Typological sequence, or typological continuity, may be said to be established when the true succession of forms have been brought out. This is the object of an educational museum. Not only must the objects be specially selected and arranged for the purpose, but the building must be adapted to the proper display of them. Architectural features, handsome halls and corridors are impediments; at any rate, they are points of secondary importance. In my address to the Anthropological Section of the British Association at Bath in 1888, I suggested a rotunda as the best form for a national educational museum of arts, a plan of which was exhibited. The concentric circles of a circular building adapt themselves, by their size and position, for the exhibition of the expanding varieties of an evolutionary arrangement. In the innermost circle I would place the implements and other relics of the Palæolithic period, leaving a spot in the actual centre for the relics of tertiary man, when he is discovered. The simple forms of the Palæolithic period would require no larger space than the smallest circle would be capable of affording. Next in order would come the Neolithic Age, the increased varities of which would fill a larger circle. In the Bronze Age a still larger circle would be required. In the early Iron Age, the increased number of forms would require an increased area; mediæval antiquities would follow, and so on, until the outer circle of all would contain specimens of such modern arts as could be placed in continuity with those of antiquity. Separate angles of the circle might be appropriated to geographical areas, and where civilisations in the same stage of development are allied to one another, they might occupy adjacent angles within the same concentric ring. Models would be largely used to explain the *gisement* of the relics exhibited. The sections and sub-sections would be divided under the head of Arts, such as Pottery, Glass, Enamels, Architecture, House Furniture, Modes of Navigation, Land Transport, Horse Furniture, Tools, Weapons, Weaving Apparatus and Textiles, Metallurgy, Painting, Writing, Music, Mensuration, Sculpture, Ornamentation, Personal Ornament, Agriculture, Hunting and Fishing Apparatus, Trapping, Machinery, Fortification, Modes of Burial, Modes of Punishment, Monuments, Coins, Religious Emblems, Toys, Heating and Lighting, Food, Clothing, Basket-making, Narcotics, Medicine, Domestication of Animals, and so forth. A manufactory of reproductions, casts, and models, would be attached to the institution, in the same manner as that established in connection with the Museum at Mayence, under the direction of Professor Lindenschmit. The museum would be divided into departments, under the control of separate keepers. By such an arrangement, the most uninstructed student would have no occasion to ask the history of any object he might be studying; he would simply have to observe its distance from the centre of the building, and to trace like forms continuously to their origin. Where breaks in the continuity of any art must necessarily occur, references might be posted to show the position of the concentric rings and cases, in which the threads of connection might be taken up again and followed. Such a museum would require constant rearrangement, as knowledge increased, and the cases might, perhaps, be put on wheels to facilitate their readjustment. An iron building with a glass roof would be the best for the purpose, and the less ornamentation it had about it, to divert the eye from the main object of the establishment, the better. Existing buildings, such as the Olympia, might, perhaps, be made use of as a commencement, as it would not be necessary the building should be round, provided the arrangement was concentric. But the Olympia would not be half large enough.

I have been much interested to learn since my address was delivered to the Anthropological Section at Bath, that Professor Flower, who has already done so much in his Natural History Department, since it was transferred to South Kensington, to arrange the collections on an evolutionary plan, has independently thought out the idea of a large rotunda, for exhibiting the development of species and varieties. A letter which I have received from him gives a rough sketch of the kind of museum that he would propose for the purpose; the present building being, in his opinion, quite unsuited for scientific arrangement. I have little doubt, therefore, that eventually this idea of concentric arrangement will be carried out, and that we shall have somewhere in the metropolis two large rotundas—one for natural history, and

the other for the arts of life. Professor Flower embodied his views on the arrangement of a natural history museum in his address to the British Association at Newcastle in 1889, in which he expounded very much the same principles for a Natural History Museum that I had advocated for an Arts Museum at the meeting of the previous year at Bath. That views so similar should have suggested themselves independently to workers in two separate departments, affords satisfactory evidence that they are in harmony with the requirements of the age.

In order to explain more clearly what my method of arrangement is, I have had prepared a number of large diagrams, to show the continuity of several of the series exhibited in the Pitt-Rivers collection at Oxford. Some of these diagrams are very old, and formed part of lectures delivered at the United Service Institution in 1858-69, the Royal Institution in 1875, and elsewhere. Others are of more recent date, and are taken from my provincial museum in Dorsetshire. Most of the diagrams were used in a lecture on my collection that was delivered lately at Oxford, at Salisbury, and other places.

Having now laid before the meeting my views upon the evolution of types, I desire to make a few remarks on the evolution of my own collection now presented to the University of Oxford.

My attention was first drawn to this subject nearly forty years ago, when, in the year 1852, I was engaged as a subaltern officer on the sub-committee of small arms at Woolwich in the experiments which led to the introduction of the rifle-musket into the army. A large number of inventions were submitted to the committee for trial; and I was then led to take notice of the very slight changes of system that were embodied in the different inventions, and also of the fact that many improvements which, not being of a nature to be adopted, fell out of use, and were heard of no more, nevertheless served as suggestions for further improvements which *were* adopted; and it occurred to me what an interesting thing it would be to have a museum in which all these successive stages of improvement might be placed in the order of their occurrence. I made a collection of arms at that time, which was the foundation of the present museum. Although this collection of arms was not a very good one, as my means of collecting were small, it led to a museum of savage weapons, and ultimately of various other arts, which were exhibited at Bethnal-green and South Kensington for nine years. Mr. Herbert Spencer, in his "Principles of Sociology," published in 1876, thus speaks of it as he saw it at that time:—"The collection of implements and weapons arranged by Col. Lane Fox,* to show their relationship to common originals of the simplest types, suggests that primitive men are not to be credited with such inventiveness as even their simple appliances appear to indicate. These have arisen by small modifications, and the selection of such modifications has led unobtrusively to various kinds of appliances without any distinct devising of them." The portion of the museum relating to arms was described in an illustrated catalogue *raisonné*, which was in fact a treatise on the development of arms; this went through two editions at South Kensington, commencing in 1877. The collection afterwards grew to such size that I was anxious to see it housed in some public building, where it would be developed in other hands on the same lines, and I ultimately presented it to the University of Oxford. In doing this I made only one proviso of any consequence, which is contained in the deed of gift, viz., "that the general mode of arrangement should be maintained, and that no changes should be made in the details hereafter, except such as should be necessitated by the advance of knowledge, and should not effect the general principles originated by me." This took place in 1884. During the seven years that have elapsed since, the museum has been re-arranged in the order in which it was exhibited at South Kensington, so that, in the main, the order of the several series is exactly the same. Some new links have been added to the old series, and some new series have been introduced. This has been done in the first place by Professor Moseley, whose death has been so great a loss to science, and afterwards by Dr. Tylor and Mr. H. Balfour, and has been carried out to my entire satisfaction in every respect, except perhaps the great length of time that it has taken to re-arrange, which, I am informed, was unavoidable, as a building had to be erected for it, for which the University very liberally voted £10,000.

But these are not times in which anything can afford to remain buried seven years, and I have had some difficulty in persuading people, now that the collection is resuscitated, that it

* In 1880 I changed my name to Pitt-Rivers, in accordance with the will of the second Lord Rivers.

is the same Lazarus that was alive before. In the meantime, however, I have formed another museum, which, although it is a provincial one, is in some respects better than the first, because such series as it contains are more fully represented. The subject of provincial museums has been lately much discussed in the newspapers. I have often observed that a little knowledge of the subject is necessary to create an interest. I have often noticed that visitors to our larger museums will wander listlessly through the rooms until they come upon something they understand a little about. Then they open their eyes and prick up their ears. It is interesting to them to compare the products of other countries and people, in those particular branches of industry that they are familiar with. A local museum should, therefore, contain a good historical series of the prevailing manufactures or industry of the locality. Acting on this principle, it appeared to me that in a rural district, sparsely inhabited, with scattered agricultural villages, and ten miles from every town and railway station, the chief feature of the collection should be agriculture and peasant handicraft.* I cannot convey my views on provincial museums better than by describing my own museum, because it has been collected from the first on a definite system, and has undoubtedly been a great success.

No. 1 Room, 20 feet by 13, contains pottery, costumes, personal ornament, now in use by peasants in Germany, France, Spain, and other nations. Some of these are of archaic design, and are probably survivals. The 2nd Room, 19 feet by 14, contains carvings by Brittany peasants, chiefly of the 17th century; French pottery in present use, and village implements of various kinds. The 3rd room, 18 feet by 13, is devoted to a series of tools, household utensils, cooking appliances, &c., of different periods. The 4th Room, 24 feet by 14, has an additional series of country tools, and here commences a general series, illustrating the history of pottery, which is continued in Rooms 5 and 6, and includes a sufficient number of specimens of each division to represent their kind, viz.:—Ancient British, Silesian bronze age, Etruscan, Egyptian, Swiss Lakes, Cyprian, Greek, Roman, Saxon, Norman, Mediæval, English toft ware, English salt-glaze, Staffordshire, and other Old English wares, Scotch pottery, German, French, Swiss, Spanish, Italian, Persian, Anatolian, Japanese, Chinese, Moorish, Peruvian, Mexican. Then follows similar specimens of glass and enamels from different countries. Another general series, not yet arranged, will be devoted to sculpture and modelling. In the 5th and 6th Rooms are models of excavations made by me in the locality, the relics from which are arranged in the adjoining cases. These are available for archæologists who may visit the district to see what it contains of local interest. Other models of ancient monuments, 95 in all, have been made under my supervision by my archæological staff, three to four in number, who are constantly engaged upon the work. These models certainly form the chief feature of the museum, and they are unique. The 6th Room, 62 feet by 19½, contains also a general series of implements of the palæolithic, neolithic and bronze periods, iron age, Roman, Egyptian, and mediæval periods. The 7th Room, 81 feet by 24, is only in process of building. The 8th Room, 85 feet by 18, is devoted to agricultural implements and appliances, and contains spades and agricultural tools of all kinds, showing the survival of the Roman wooden iron-edged spade in several parts of Europe; querns and grain-rubbers, some of which are in present use; a Norse mill, showing the earliest application of water power to the quern; grinding and winnowing machines; some models of crofters' cottages; a series of models showing the varieties of ploughs in present use in different countries; country carts, explained in the same manner by means of models; a series showing the development of locks and keys; a series of crates carried by country women of different countries on the shoulder, and collected expressly to show the women of my district how little they resemble the beasts of burden they might have been if they had been bred elsewhere. All these things are well ticketed, but an explanatory catalogue has yet to follow.

It would be a mistake, however, to suppose that the agricultural labourer can be reached by museums alone. Hodge, though better off than he has ever been before, is in a lower condition, morally and mentally, than at any previous period. He is too incessantly plied with pernicious doctrines to have a soul for anything above party politics. It is to the larger and smaller tradesmen in the towns and villages that such things as museums appeal, and, moreover, they must be supple-

* The population of Farnham and the neighbouring parishes is:—Farnham, 301; Handley, 868; Tollard Royal, 247.

mented by other inducements to make them attractive. Within a short distance of the museum, I have formed a recreation ground, called the Larmer Grounds, where my private band plays every Sunday in the summer months from three to five. This ground was attended during the last year by 16,839 persons from the neighbouring towns and villages. Not far off is an old house, formerly a hunting box of King John, which is open to the public, and were any amount of bread and butter, tea and buns can be obtained at slight cost. This during the last year drew 4,346 persons. The visitors to the museum in the same year amounted to 7,000 persons,* and the numbers at all three places have been increasing year after year. The people come from a radius of 20 miles round, and it has been very successful, in so far as the number of visitors is concerned. I have built a small Museum Hotel, at which visitors to the locality can put up, and which has first-class accommodation. Another, called "King John's" Hotel, has sprung up in an adjoining village. It has become the head-quarters of a local bicycle club, which is named after the place. Bicycling is an institution that must not be overlooked in any project for the improvement of the masses. The enormous distances bicyclists can go by road, especially on a Sunday, has rendered the population of country districts locomotive to an extent that has never been known before. Fifty to sixty bicycles are frequently seen at my Sunday meetings at the Larmer grounds, which average from 600 to 1,000 people; and the church on Sundays is crowded.

It is a mistake to suppose that the country towns are the best localities for such museums. Townspeople have other things to do than to visit the museum, which they can see every day, and which soon begins to pall upon them. The visitors from the country into the towns generally go there for business purposes, and have no time for museums. In the town of Dorchester, in which there is a museum equal in size to mine, and scarcely less attractive, I found that the attendance was only 2,826 during the year 1888, as against 7,000 at my museum in 1891. The outing is in itself an important accessory in a visit to a country museum. A pretty country, a pleasant drive in their country carts, an attractive pleasure ground, a good band, and lastly a museum, are the means which I have found successful, and which I am justified in recommending to those who wish to draw the people out of the towns into the country. But I do not wish to infer that I think any permanent good can be done in this way at the present time. Against agricultural depression, caused by foreign competition, it is impossible to contend. Burdens may be shifted from one shoulder to another by legislative enactments; but against the evil itself there is no redress on the political horizon, and, as long as that is the case, it is uphill work to fight against it, even though a landowner may spend his whole income in the endeavour to do so. The land, as a whole, will not produce one grain of wheat more, probably much less, by subdividing the ownership—substituting a large pauper population for a small and comparatively wealthy one, and driving capital away from it. The very reverse is the process that should be encouraged.

Public attention has of late been drawn a good deal to the advantages of museums in the Press. I am not myself so hopeful of the result as would induce me to devote the time and attention to the subject that I have done, had it not been to me, for many years, a hobby and an amusement. If no more good came of it than to create other interests, which would draw men's minds away from politics, that greatest of all curses in a country district, good would be done. If only a more scientific knowledge of the arts of life, and of the laws of nature affecting the development of those industries by which the working classes gain their living, the results would be beneficial. I have already hinted my belief that, by analogy, museums might be made the means of inculcating sounder views on social questions, and that they afford the only opening available to people who have so little leisure for study.

Whether or not my more ambitious scheme for a Typological Museum fails to be realised, at any rate my Provincial Museum may be claimed to be a success, judging by the constantly increasing numbers that are found to visit it, and that in a district which, at first sight, appeared very unpromising.

At the conclusion of the paper, General Pitt-Rivers exhibited and described a number of diagrams illustrative of his collection. The first was ones showing the evolution of the modern rifle and bullet through all its stages, some of which had entirely dropped out of public knowledge; and in connection

* This is the ordinary number of visitors, and does not include lectures or other meetings.

with this, he suggested the desirability of a similar series being arranged, before it was too late, of various electrical appliances, many links in which might easily be forgotten. Next came a large diagram showing the arms of savages, which in the beginning were constructed of mere natural sticks and portions of branches, thus giving the form to the weapon which was sometimes imitated afterwards, when the art became more advanced. Flint implements came next, and arrow heads, the leaf-shaped being the earliest. Bronze and iron weapons were not always copied from wooden ones, though a similarity in shape might sometimes be traced; this was illustrated by a series of sword-forms. When metallurgy was first introduced, only small pieces could be cast, and therefore short daggers were the earliest forms of this class of weapon; the copper implements were of the simplest form, and the later iron ones more complex. One particular shape of sword was found over a large portion of Asia, being very similar to a Greek sword figured on vases, and it was probably derived from the Greeks. Another series of diagrams was devoted to the development of ornament, and showed the changes which the loop, coil, and fret pattern had gone through; and another showed the cross, which, as a Christian symbol, was plainly derived from the Greek letters XP conjointly, which led naturally to the Celtic cross, still largely found in Scotland, whilst the Latin cross was a later form. The degradation of silver coins, from the stater of Philip of Macedon, was also shown. Another diagram illustrated how changes occurred through mistakes in copying, and were continued and increased until ultimately the original pattern was hardly recognisable. This was especially the case in representations of the human countenance, and had, in the opinion of Gen. Pitt-Rivers, led Dr. Schliemann into an erroneous belief that the figures found on certain vessels at Hissarlik were Trojan remains, as bearing the image of the owl-faced goddess, Glaukopsis Athene, whereas, in truth, there was nothing of the owl-face about them, but merely a degraded and conventionalized type of the human face.

DISCUSSION.

The CHAIRMAN said a great deal had been heard lately about the flow of people from the country into the towns all over England, but this paper showed how, by proper means, the population of the towns might be attracted to the country. He agreed with General Pitt-Rivers that the main object of the British Museum was to serve as a storehouse for the researches of savants, but in addition to that, there was room for some educational work to be done in some of the public galleries, and, under the direction of Professor Flower, something had been done in that direction in the Natural History Museum. He thought there would be some difficulty in introducing the word typology, because in natural history the word type had a particular meaning, and the type of a particular class of objects was one which exhibited the special peculiarities of the whole group; it would be rather confusing to use the word in a new sense.

Dr. E. B. TYLOR, F.R.S., said he could not add anything to the excellent account General Pitt-Rivers had given of his system of arranging museums, but he felt that the greatest of these museums, which would mark itself in no insignificant way on the present generation, ought not to be described without someone from the University of Oxford being present to bear testimony to the importance of the educational system it represented. Before this Oxford Museum was established, it was usual to look upon a museum as an assemblage of curiosities, which had to be pointed out and explained to the visitor with great care; otherwise even the most illustrative cases would make but very little impression on the ordinary untrained spectator. But the Pitt-Rivers Museum affected the mind of the intelligent stranger quite differently. There was no trouble to explain the system upon which it was worked. There might be some little trouble, even with the aid of good illustrations when, as on the present occasion, the actual specimens were not on view; but, when they were properly arranged, the slightest hint was sufficient to convey to the intelligent mind what they were there for; and then they told their own story. Very recently, there had been a good example of how it was educating the world at large. It often happened that a series might be made purely theoretical, by putting in their order a number of specimens which referred to one another more or less distinctly, thus showing where the curve of development had probably passed; but yet important links were often wanting, and the visitor went away possessed with the desire to find those links and present them to the Museum. Only a few weeks ago, they thus acquired a much desired link in in the history of stringed instruments. The late Mr. Carl Engel suggested that the strung bow must have been the origin of the whole series of stringed instruments, whether pianoforte, violin, or guitar. This view was proved to be correct when the instruments were arranged in a series, beginning with a strung bow. The difficulty, however, was to get the starting point—an authentic bow capable of being used both for hunting and twanging. One people, who were described as using the bow for this double purpose, were the Damaras; it was said that the hunter shot game with his bow during the day, and when he came home, sat by the fire and amused himself by twanging the string. Three or four weeks ago Miss Lloyd, who had spent some time in South Africa, sent them one of these bows, and it now stood at the head of the series of stringed instruments. He believed the idea of General Pitt-Rivers was destined to bear good fruit on the actual development of mankind. It had dissipated some notions as to the wonderful originality of early inventions, which, when seen in

connection with what had gone before, were found to be the natural product of a mind perhaps a little in advance of its fellows, but still in the main not so far removed from them. Although all country and county museums could not be expected to become museums of development, yet it was possible for them to treat local arts and other matters in that way. A country museum would very well show, in connected series, the arts and manufactures on which the people in the neighbourhood depended for their livelihood, and this could hardly fail to be useful in promoting further progress.

Sir George Bowen, G.C.M.G., said he had been much interested in seeing so well represented many of the arms of the aborigines of Australia, with which he became familiar during his twenty years' governorship of different colonies in that quarter of the globe.

Mr. F. W. Rudler said he had the privilege, many years ago, of becoming acquainted with the Pitt-Rivers collection, but he had never heard it called a Typological Museum before. Still, some distinctive title was required, the principle followed being so different from that usually adopted. Anyone who inspected it would be struck, not so much by its variety and magnitude, as by the obvious fact that all the specimens had been collected for a definite purpose, and arranged in a unique manner. In order to illustrate the evolution of the different types most effectively, a linear series was, no doubt, undesirable, and one could not but look with admiration on the project for an Anthropological Rotunda, but still, even such a scheme might, he thought, be open to improvement. Looking at the central circle representing the palæolithic period, it occurred to him that in walking round it, being a closed curve, one would never make any progress. You passed by a jump to the next circle, representing the neolithic, and though no doubt a great gap appeared between the two periods, that only arose from our ignorance. It seemed to him that a continuous spiral would, in some degree, be a better arrangement than a series of circles. If the Albert-hall could be cleared out, a good start might be made there. The question the General had raised was only part of a very large subject now under discussion by the Museum Association, a body which was moving somewhat on the lines of the Library Association, and which had already done good work. If General Pitt-Rivers would favour that association with his views on museums, he was sure he would receive the greatest possible sympathy, for all the curators who constituted the association were strongly imbued with the belief that a museum was one of the most important educational engines which could be developed.

The Chairman then proposed a hearty vote of thanks to General Pitt-Rivers, which was carried unanimously.

General Pitt-Rivers, in reply, said that, in tracing any particular series, there was always a danger of letting the imagination run riot to a certain extent; but where the same system became developed, as Dr. Tylor had shown it was now doing at Oxford, there was some guarantee that the principles established were correct. With regard to Mr. Rudler's remarks, he could only say that he had already suggested that the cases might be put on wheels, so that the arrangement might be altered from time to time as required. He was quite aware of the difficulty of introducing the word typology with regard to natural history, but he had never proposed to apply it to such specimens—only to continuity in the sequence of the arts of life.

Miscellaneous.

NOTES AND HINTS ON THE VEGETABLE PRODUCTS OF TROPICAL AFRICA.

By John R. Jackson.

[Continued from page 110.]

Oils and Fats.

There is always a brisk demand for vegetable oils in the markets of Europe, and, notwithstanding the spread of gas and of the use of the electric light, the demand is increasing, rather than diminishing. The largest number of new oil seeds that find their way to the English ports come from the west coast of Africa, and too often come without the slightest clue to their botanical identification. When new seeds are sent, a specimen of the plant, with flower and fruit, should accompany them. The necessity of the name of the plant being known is sufficiently obvious, for this knowledge often carries with it an indication of the nature or properties of the seed—whether the oil it contains is wholesome or poisonous or likely to prove useful for medicinal purposes or otherwise.

A large number of new oil seeds have come into the English market from the west coast of Africa during the last few years, but the supplies have mostly been intermittent. The following are amongst those to which some attention has been given, and for which, apparently, there would be a market if a constant supply was forthcoming.

Telfairia occidentalis.—This is a climbing plant belonging to the cucumber family (Cucurbitaceæ). The seeds, which contain a large quantity of sweet bland oil, are circular, about the size of a penny, and half an inch thick, covered with a net-like coating. They are contained in a large, ovoid, strongly ribbed, woody fruit, 12 to 18 inches long. The seeds themselves, when cooked, are taken as food by the natives. They are occasionally imported into Liverpool as oil seeds.

Under the name of "mutugo," the seeds of a kind of nutmeg (*Myristica angolensis*), a native of Angola, were first imported into Liverpool as oil seeds in 1884, and occasionally come into the same port at the present time in small quantities. They are said to contain about three-quarters of their weight of fatty oil. They are about three-quarters of an inch long and half an inch broad; they are ruminated or marked with irregular dark lines, like ordinary nutmegs, but have no smell, and very little taste.

Hyptis spicigera.—An herbaceous plant, belonging to the natural order Labiatæ, to which order belong the mint, sage, lavender, rosemary, &c. The seeds are very small and black, and contain a large proportion of oil. They were first imported in Liverpool from West Africa in 1883, and are still occasionally brought. In the West African Court of the Colonial and Indian Exhibition, in 1886, quantities of these seeds were exhibited.

Polygala rarifolia.—A shrubby plant, belonging to the Polygaleæ, or milkwort family. It is a native of Sierra Leone and Angola, and the seeds, which are small, and of a shining chocolate brown colour, are very rich in a clear oil. They are known as "maluku" seeds, and are sometimes brought into Liverpool, having made their first appearance in 1884.

Lophira alata.—A plant belonging to the order Dipterocarpeæ, a group of plants characterised by their resinous products rather than by their oils or fats; therefore, plants allied to *Lophira* might be expected to yield resins that should be useful in varnish making. The fruits of *Lophira alata* are somewhat oval, broad at the base, and pointed at the apex, two lobes of the calyx at the base are extended into wings (a distinct character of the Dipterocarpeæ). Each fruit contains a single seed, the oil of which is expressed in Senegambia, and used for cooking as well as for anointing the hair. The seeds frequently come in small quantities into the Liverpool market. They are generally known under the name of "Meni," but in Sierra Leone as "Laintlaintain."

Pentaclethra macrophylla.—A tree 50 to 60 feet high, belonging to the Pea family (Leguminosæ). The pods are from 18 inches to 2 feet long, 3 inches wide in the middle, tapering at both ends, and about 1 inch thick; they are of a brown colour, woody, and very strong. The seeds which they contain are irregularly oval, flattened, about 2 inches long by 1 inch broad in the middle, and about ¼ inch thick, of a shiny, chocolate brown colour. These seeds are eaten as food on the Niger, and the oil, which is expressed from them in large quantities, is used for cooking and also for greasing machinery, and is said to be a good oil for soap-making. The seeds sometimes find their way into Liverpool. The tree has been found in Senegambia, Fernando Po, Camaroons River, St. Thomas Island, Prince's Island, Gaboon, &c. It is the "Owala" of the Gaboon, and the "Opachala" of the Eboe country.

"M'poga" nuts, "Mabo" nuts, and "Niko" nuts. Under these three names, the hard bony fruits, without the fleshy coverings in which they are enveloped when fresh, come occasionally into the port of Liverpool from West Africa—mostly from Liberia and the Gaboon.

M'poga fruits are about 2 inches long, and from 1 to 1½ inches in diameter. They contain three or four roundish seeds, from which a very large percentage of oil can be expressed. The fruits of the mabo are oblique-ovoid in form, about 2 inches long and 1 inch in diameter; externally, they are very rough or channelled; the seeds of this nut are also rich in oil of a very fluid character. These fruits and seeds are both imported from Liberia. Niko nuts, which come also from Liberia, are of a similar bony nature, about 2 inches long and 1½ inches in diameter. The seeds, like the other kinds, contain a large proportion of oil. Neither of these have become established articles of trade, though the oil seems to be of a character that might become useful. Owing to the want of authentic specimens of leaves and flowers of the plants producing these fruits they have never been botanically identified. They may, perhaps, be a species of the genus *Parinarium*, belonging to the *Chrysobalaneæ*, a section of the Rose order (Rosaceæ), or more probably to the genus *Elæocarpus* of the natural order Tiliaceæ. It is very important to collect complete botanical specimens of all these plants and transmit them to this country for determination.

The seeds of any unknown plants should be examined for the presence of oil, and if found to contain oil, should be collected in sufficient quantity for experiment. Seeds thus collected for trial should always be accompanied by foliage, flowers, and fruits of the plant, by which means their botanical affinities and consequent name may be determined.

[To be continued.]

Notes on Books.

RULERS OF INDIA: CLYDE, AND STRATHNAIRN. By Maj.-Genl. Sir Owen Tudor Burne, K.C.S.I. Oxford: Clarendon Press, 1891.

The contents of the fourteenth volume of the "Rulers of India" series, which Sir William Hunter is editing for the Clarendon Press, are perhaps more fitly indicated by its second title, "The Suppression of the Great Revolt;" for the book is actually a clear though brief account of the Indian Mutiny, from its outbreak in May, 1857, to its final suppression in August, 1858, and the transfer of the powers of the East India Company to the Crown. It is only because they were the actual figures of the campaign that Sir Colin Campbell and Sir Hugh Rose were selected to give their names to this book.

To compress into the limits of 200 pages a narrative of a time so crowded with events, so full of interest, and so important in its results, was no very easy task, especially as the details of the history are still fresh in the memory of all who have reached middle age. It is only when, by lapse of time, details are forgotten, and when the generation which has made the history has passed away, that the really important events can be reviewed in their true magnitude, and history can be written. The time has perhaps come when it has become possible to estimate in their true proportion that series of rapidly changing events which began by nearly severing India from the British Crown, and ended by uniting the two empires in closer bonds than before.

To do this in a succinct and yet popular manner has evidently been the object of the writer, whose former connection with the two great soldiers above mentioned gave him special facilities for acquiring an intimate knowledge of the movements he describes; and the judicious manner in which the task has been accomplished will render his work useful, not only to the student of Indian history, but also to the larger public who may welcome an impartial record of the events connected with the last great crisis in the history of our country.

ELECTRICITY UP TO DATE. By John B. Verity. London: Warne and Co.

This is a popular manual, intended for the growing class of users of electricity. The necessary apparatus and plant employed for electric light installations is described, dynamos, arc and incandescent lamps, storage batteries, conductors, &c. The method of mounting and making a private installation is described, and the needful amount of information is provided for those who are in a position to obtain a supply of electricity from a public source. Chapters on the employment of electricity for motive power complete Mr. Verity's treatment of his subject.

TEXT BOOKS OF ORNAMENTAL DESIGN; NATURE IN ORNAMENT. By Lewis F. Day. With 123 plates and 192 illustrations in the text. London: B. T. Batsford.

In this profusely illustrated book Mr. Day deals fully with the multifarious aspects in which nature has been treated in ornament, and with those in which it can be treated with advantage. He divides his subject as follows:—Ornament in nature, nature in ornament, simplification of natural forms, elaboration of natural forms, consistency in the modification of nature, parallel renderings, tradition in design, treatment of animals in ornament, element of the grotesque, still life in ornament, and symbolic ornament. The author is not sanguine as to the conversion of the popular mind to the true principles of design; and he says that there is even still a superstition that ornament is designed by the aid of the kaleidoscope. He strongly urges the adoption of a special artistic treatment of nature, whether it is called conventionalism, or given any other name. On this he writes:—"Art passes through periods of affectation, when it becomes, before all things, urgent that opinion should be led back again to the forgotten grass-grown paths of nature. That is not our urgency now. If there was at one time within our memory some fear of artificiality in art, the danger now lies in the opposite direction of literalism; a literalism which assumes a copy of nature to be not only art, but the highest form of art; which ignores, if it does not in so many words deny, the necessity of anything like imagination or invention on the part of the artist, and accepts the imitative faculty for all in all."

He further affirms that the conventions of artists are not so far removed from nature as we are apt to think, and adds, that "trees do grow in Umbria as Perugino, and Raffaelle after him, painted them."

Mr. Day contends that, although it is necessary for the artist to know what has been done by others before him, he must make his convention for himself, and not accept one ready made. To accept the academic view, that some old, or more or less obsolete style, such as classic, Mediæval, or Renaissance is to be servilely followed, is to agree that "the tombs of buried peoples are heaven-sent habitations for live men."

He gives many illustrations to show how certain emphatic natural forms may be used in design, and, although they are exhibited in a rudimentary form, their identity can be seen; so that vitality of foliage may be seen to exist even in stone. He instances an example of a panel by the architect Street, in which the thistle is characteristically and energetically treated, although shorn of its leaves, its prickles, and the featheriness of its flower heads.

The examples which the author has collected are very varied, and exhibit the treatment of nature in design at different periods in various nations, as well as in many materials.

General Notes.

CHICAGO EXHIBITION.—It is stated that France has made application for 130,000 square feet of space in the Exposition buildings. The application for space for France was filed recently by M. Bruwaert, the French consul stationed at Chicago. He asked for the following allotment of space:—In the manufacturers' building, 100,000 square feet; in the fine arts building, 20,000; in the machinery hall, 10,000. The consul also desired space in the mines and mining, agricultural, and horticultural buildings. He announced at the same time that France would probably not construct a special State building.

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FRIDAY, DECEMBER 25, 1891.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, by Professor JOHN M. THOMSON, Sec. C.S., on "Three States of Matter: Solid, Liquid, and Gaseous."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Chicago Exhibition, 1893.

The following Chambers of Commerce have consented to act as Local Committees in connection with the Royal Commission :—

London,	Leicester,
Barnsley,	Lincoln,
Barrow-in-Furness,	Pembroke,
Cardiff,	Sheffield,
Dundee,	Southampton,
Edinburgh,	Sunderland,
Exeter,	Wakefield,
Halifax,	Worcester.
Hull,	

The following Chambers, while unable to act as Local Committees, have expressed their readiness to distribute information in their respective districts :—

Birmingham,	Leith,
Glasgow,	Nottingham,
Greenock,	North Staffordshire.

Proceedings of the Society.

CANTOR LECTURES.

PIGMENTS AND VEHICLES OF THE OLD MASTERS.

By A. P. LAURIE, M.A.
King's College, Cambridge.

Lecture I.—Delivered November 30th, 1891.

The subject to which these lectures are devoted is one so wide reaching, and so complex, that it is only possible to deal with certain aspects of it, and take up a few points that seem of especial interest. Perhaps I cannot begin better than by stating clearly what I do not mean to do. In the first place, there is a great deal of information which is common property on this subject, and which I do not propose to consider here. We all know that the various coloured earths and ochres have been used in painting from the earliest times, and that they are permanent under the test of hundreds, indeed, thousands of years. We know that before the introduction of oil painting, white of egg was the favourite medium, and that oil painting in its main features has always been the same. I do not propose, then, to waste your time in considering in detail matters familiar to everybody already.

I have been studying for some years the literature of this subject, and, testing the statements contained therein, as far as I could by experiments in the laboratory, and I think I have succeeded in clearing up a few points and answering a few questions. I propose to give you here, as briefly as possible, what seems

to me to be the essential points in the technique of the old masters—the essential points, that is, regarding the picture, not as a work of art, but as a job executed in pigments, and meant to stand as long as possible without deterioration. On the whole, it seemed best to arrange the subject under three heads:—

(1) The preparation of the painting surface.

(2) The pigments; their preparation and properties.

(3) The mediums.

No doubt there will be some referring backwards and forwards, even in this arrangement, from one part of the subject to another; and I must further warn you that I shall not regard dates, but shall jump from a 15th century panel to the lid of an Egyptian coffin of 1500 B.C. without the slightest hesitation, if it suits my purpose. What we want, I take it, are good practical working methods, from any source that we can get them, while, at the same time, rejecting all vague uncertain utterances. The torment of the writings on these subjects is the amount of vague, speculative material introduced, with no distinction between what is known and what is guessed at.

We shall begin, then, by discussing the preparation of panels for painting, as very complete information can be obtained on this subject. Unfortunately, nothing so accurate seems to be known about the preparation of canvas. I shall not touch on that subject here, as much sifting of evidence is required first. To begin, then, with panels, our principal authority will be the MS. of Cennino Cennini, translated by Mrs. Merrifield. Cennino Cennini was a pupil of Agnolo, himself a pupil of Giotto, and wrote in 1437. This work is invaluable, especially as throwing light on the methods of fresco and tempera painting. It was first published in Italian by Tambroni, in 1821, and translated by Mrs. Merrifield in 1844.

Panels.

In preparing a panel for painting, it is essential that the wood should not warp or crack, and that the layer of plaster or gesso on the panel should not be liable to crack off. We accordingly find special precautions taken to guard against these dangers. Probably, the best guard against cracking and warping is to have *thoroughly* seasoned wood. This is not easy to secure, unless the wood has been stored by yourself. But there is another precaution for small panels, given by Cennino Cennini, which is interesting. He advises *boiling* them in water, to prevent warping or cracking. I have made some enquiries into this, and I find that it corresponds somewhat with a modern practice, namely, the steaming of wood to get it seasoned rapidly. I do not find, however, that this practice is regarded as the best by carpenters. They consider that slow air drying is the best. Apparently, the most important matter is to season the panel after it is cut to its final shape and size. The panel should be cut in summer and kept to next summer. If this is done, some will warp, twist, and crack, and may be rejected; others will survive the test, and are thus safe. The careful selection and seasoning of the wood is of the first importance. Cennini says little about it. He, probably, trusted to his carpenter to see to that for him.

Having now obtained a piece of wood of suitable size and shape, we must next prepare it with a fine surface of gesso, on which the picture is to be painted. Obviously the important point now is to prevent the possibility of the gesso peeling off. This can best be prevented by thoroughly roughening the surface of the wood, so as to give a tooth on which the fine plaster can hold, just as a plasterer marks his rough lime with the trowel, in order to enable the fine lime finishing the wall or ceiling to firmly adhere. This, then, being the most important matter, you will not be surprised to hear that the intelligent maker of panels for painting at the present day carefully smooths his wood before laying on the gesso.

Before quoting in full, as I propose to do, Cennino Cennini, on this matter of panel preparation, I shall briefly refer to the method used by the Egyptians in certain cases. The wooden coffin lids were prepared for painting on by being first coated with gesso, and it was my good fortune to be presented with a small crumb of such a coating by Professor Middleton, obtained from a coffin in the British Museum. There was a streak of blue pigment on this fragment, of which I shall speak in my lecture on pigments; but with that we have nothing to do at present.

On examining this portion of prepared surface, I found a thin coating of fine white plaster lying over a dark brown substance, resembling oil-cake in appearance.

I was somewhat troubled to make out what this substance could possibly be. It seemed about 1-16th inch thick, and must have lain between the white plaster and the surface of the wood. On moistening the fragment with

hot water it fell to pieces, the binding cement, or gum being dissolved, and then, on examining under a glass, the nature of this substance was revealed. It consisted of grains of sand mixed with wood fibres.

The way in which the panel had been prepared was now sufficiently obvious. The surface of the wood had been rubbed and torn up with sand mixed with gum water. Then the whole surface had been smoothed down, sand, wood fibres and all, and allowed to harden. Then on this curious concrete, bound to the wood by partially torn fibres, the fine white gesso had been laid. You see here some attempts to imitate this method of our own preparing, and I can safely recommend it. It has stood the test of 3,000 years. Passing, then, from this ingenious method, let us consider how Cennino Cennini mastered the same difficulties.

I cannot do better than quote directly from his work:—

"CHAP. 113.—*How to begin to Paint Pictures.*

"Now we are really going to paint pictures. In the first place, a panel of the wood of the poplar, lime, or willow tree must be prepared, on which to paint the picture. Let it be made quite smooth. If it be defaced with knots, or if it be greasy, you must cut it away as far as the grease extends, for there is no other remedy. The wood must be very dry; and if it be such a piece that you can boil in a cauldron of clean water, after the boiling it will never split. Let us now return to the knots, or any other defect in the smoothness of the panel.

"Take some glue (*colla di spicchi*), and about a glassful of clean water; melt and boil two pieces (*spicchi*) in a pipkin free from grease; then put in a porringer some sawdust, and knead it into the glue; fill up the defects or knots with a wooden spatula, and let them remain; then scrape them with the point of a knife till they are level with the rest of the panel. Examine if there be any nail, or other thing that renders the panel uneven, and knock it into the panel, then provide some pieces of tinplate, like *quattrini* (small pieces of money), and cover over the iron with them; and this is done that the rust of the iron may not rise through the ground. (1.) The surface of the panel cannot be too smooth. Boil some glue, made of parchment shavings, till the water be reduced to one-third of what it was at first, and, when put on the hands, if one hand stick to the other, it is sufficiently boiled. Strain it two or three times, put half this glue into a pipkin, add a third part water, and boil well together; then, with a hog's-hair pencil, large and soft, pass a coat of the glue over the panel, or foliage, or pyxes (*civori*), or columns, or whatever you work upon, that is to be covered with a ground (*ingessare*), and let it dry; then take some of your first strong glue (*colla forte*), and pass twice over you work, letting it dry well between each coat of glue, and it will be glued to perfection.

"Do you know the effect of the first glue? A weak water or liquor is absorbed from it by the wood, which operates exactly as if, when fasting, you eat a few comfits, and drank a glass of wine, which gives you an appetite for dinner; so this glue prepares the wood for the glue and grounds to be applied afterwards.

"CHAP. 114.—*How to fasten linen on panels.*

"Having thus spread the glue, get some linen cloth, old, fine, and white, and free from grease. Take your best glue, cut or tear this linen into large or small strips, soak these in the glue, and spread it with your hands over the surface of the panel; remove the seams, and spread it well with the palms of the hands, and leave it to dry for two days. And remember it is best to use glue when the weather is dry and windy. Glue is stronger in the winter. For gilding, the weather should be damp and rainy."

"CHAP. 115.—*How to lay grounds of gesso grosso on the surface of a picture with a spatula* (1).

"Where the panel is very dry, take the point of a knife like a rasp (*mello*), rasp it well, and make the surface quite even. Then take some gesso grosso, that is to say, volteranno, purified, and sifted like flour. Put a porringer full on the porphyry slab, grind it well with this glue, as you would grind colours, collect it, and put it on the surface of the pictures, and, with a very smooth and rather large spatula, cover the whole surface, and wherever you can use the spatula do so.

"Then take some of this ground plaster (gesso), warm it, take a soft hog's-hair pencil, and give a coat on the cornices and foliage, and on the even surfaces with the spatula. Give three or four coats on the other parts of the cornices, but on the other level parts you cannot use too much. Leave it to dry for two or three days. Then take the iron rasp (*mesella*) (2), and level the surface; procure some small iron rods, which are called raffiette, such as you will find in the painter's, who use several kinds of them. Pick out all the cornices and foliage which are not flat, and with these make every part of the surface of the ground smooth and free from knots."

"CHAP. 116.—*How to prepare a fine ground* (*gesso sottile*) *for pictures.*

"You must now prepare a plaster for fine grounds, called gesso sottile. This is made from the same plaster as the last, but it must be well washed (*purgata*), and kept moist in a large tub for at least a month; stir it up well every day until it almost rots (*marcise*), and is completely slacked, and it will become as soft as silk. Throw away the water, make it into cakes, and let it dry; and this plaster (*gesso*) is sold by the apothecaries to our painters. It is

used for grounds for gilding, for working in relief, and other fine works."

"CHAP. 117.—*How to prepare a ground of gesso sottile on a picture, and how it is to be tempered.*

"Having laid on the gesso grosso, rubbed down the surface, and polished it well and delicately, put some cakes of the gesso sottile into a pipkin of water, and let them absorb as much as they will. Put a small portion of it at a time on the porphyry slab, and, without adding any water to it, grind it to an impalpable powder. Put it then on a piece of linen cloth, strong and white. When you have ground as much of it as you want (for you must consider what quantity you will want that you may neither have to make two portions of tempered plaster, nor to throw away any good plaster), take some of the same glue with which you tempered the gesso grosso. You must make sufficient at one time to temper both kinds of gesso. The gesso sottile requires less tempering than the gesso grosso; the reason for this is that the gesso grosso is the foundation of all your work, and that how much soever you press the gesso grosso a little water will still remain in it. For this reason make the same kind of glue for both. Take a new pipkin which is free from grease, and if it be glazed so much the better. Take a cake of this gesso sottile, and scrape it fine with a knife, as you would cheese, and put it into the pipkin. Put some of the glue on it, and stir the gesso as you would a paste for making fritters, smoothly and evenly, until there are no longer any lumps. Procure a cauldron of water, and make it very hot, and put into it the pipkin containing the tempered gesso. Thus the gesso will become warm, but will not boil; for if it should boil, it would be spoiled. When it is warm, take your picture, and a large and very soft pencil of hog's bristles, dipped in the pipkin, and taking up a proper quantity at a time, neither too much nor too little, spread it evenly over the level surfaces, the cornices, and the foliage. It is true that in doing this the first time you should spread and rub the gesso with your fingers, and hand, wherever you can, and this will incorporate the gesso grosso with the gesso sottile. When you have done this, begin again, and spread it with the brush, without touching it with the hand. Let it rest a little, but not so long as to dry thoroughly; then pass over it a third time with the brush, and let it dry as usual. Then give it a coat on the other side; and in this manner, always keeping gesso warm, give the panels eight coats. Foliage and *relievos* require less, but you cannot put too much on cloths. This is on account of the rasping or rubbing down, which is done afterwards."

"CHAP. 120.—*How to begin to smooth the surface of a panel on which you have laid a ground of 'gesso sottile.'*

"When you have finished laying the ground (which must be done in one day, even if you work at it in the night, in order to complete it in the usual way), let it dry in the shade for two days and nights at least. The drier it is the better.

"Tie some powdered charcoal in a piece of linen, and sift it over the ground of the picture. Then, with the feather of a hen or goose, spread this black powder equally over the ground, because the panel cannot be made too smooth, and because the iron with which you rub the picture is smooth also. When you remove it, the ground will be as white as milk, and you will then see whether it requires more rubbing with the iron."

"CHAP. 121.—*How to plane surfaces on which 'gesso sottile' has been laid, and of what use the planing is.*

"Take a flat raffieto, about as wide as a finger, and gently rub the surface of the cornice once; then, with a sharp rasp (*mella arrotata*), which you must hold as freely and lightly as you possibly can, rub over the surface of the panel with a very light hand, brushing away the loose gesso with the feather. And know that this dust is excellent for removing grease from the pages of books (*carte de libri*).

"In the same manner rub smooth the cornices and foliage, and polish them as if they were ivory. And sometimes (for you may have many kinds of work) you may polish cornices and foliage by rubbing them with a piece of linen, first wetted and then squeezed almost dry."

The bands of old linen evidently serve the purpose of the sand in the Egyptian method. They afford a tooth for the plaster, and at the same time must help to hold the panel together, and also help to prevent soap or resin rising through the gesso surface. Apparently linen was also used for the best coffins in Egypt in the same way.

The Gesso Volterrano is, according to Mrs. Merrifield, plaster of Paris, which was obtained from some gypsum quarries in the neighbourhood of Bologna, and Vasari gives a long account of this Gesso Volterrano in his life of Andrea Verrocchio, who used it to make casts of dead persons.

It will be noted that the gypsum for the final coating of gesso is thoroughly slaked by keeping in water for some weeks.

A very fine example of gesso work exists in the old cathedral church at Coire. They have there a box which they claim to be as old as the ninth century. It is entirely covered with gesso, on which a design in low relief has been roughly scrolled. The gesso has been polished so as to give the appearance of ivory. At the corners, where it has got chipped off,

the ends of the linen can be seen, which has evidently been put next the wood, as Cennino Cennini advises. There is nothing, I think, in the whole of this account which could not be easily reproduced at the present day. I have here a mahogany panel which has been prepared by a picture frame-maker, from Cennino's directions.

Gilding.

Having completed the preparation of the panel, we can now paint upon it, or, as was usually done in the earlier Italian pictures, cover it completely with gold leaf.

For this purpose Cennino Cennini mentions three mordants that can be used; one prepared from white of egg and Armenian bole, one a quick-drying oil varnish similar to the gold size now used, and one prepared from garlic juice. He devotes some space to the account of gilding done with the white of egg medium, which I shall quote in full. The only trace of this method of gilding left now is the use of white of egg by bookbinders in gilding books. The bole is used in water-gilding now with parchment glue.

"Chap. 131.—*How to lay bole on panels, and how to temper it* (1).

"Let us return to our subject. When you have finished the relievos of your picture, procure some Armenian bole and try whether it be good. Touch your under lip with it; if it stick to it, it is good. You must now learn the best tempera for gilding. Put the white of an egg into a very clean glazed porringer. Make some twigs of broom into a rod, and beat up the white of egg with it until the porringer is full of thick froth, which appears like snow. Then take a common drinking-glass, not too large nor too full of water, pour it on the white of egg into the porringer. Let it stand from night till the next morning, to clarify itself. Then grind the bole in this tempera as perfectly as you can. Next dip a clean soft sponge into clean water, and squeeze it dry; rub lightly with the sponge (not too wet) on these parts, on which the gold is to be laid. Then pass over it, for the first time, with a large pencil of minever, a coat of this tempered bole as liquid as water, and, wherever the gold is to be used (having first sponged the part with water), spread the bole very evenly, being careful not to stop, so that you may leave no hard edges with your pencil. Then wait a little; put a little more bole into your porringer, and let the second coat of colour have a little more body. Give it this second coat, and let it again rest a short time; put more bole into the vase, and give it a third coat in the same manner; making no hard edges. Put more bole still in the vase, and give it a fourth coat, and then you will have finished laying on the bole. Now you may cover over your panel with a cloth, to keep it as much as you can from dust, sun, and water.

"Chap. 134.—*How to gild panels.*

"When the weather becomes damp and cloudy, and you wish to lay on any gold, place your panel flat on two trussels. Sweep it with a feather, and, with a raffietto, pass very lightly over the ground of bole, and if you find any knots or roughness remove them. Burnish the bole very carefully with a piece of coarse linen. If you afterwards burnish it with a tooth, it cannot look otherwise than well. When you have thus cleaned and burnished it, put into a glass nearly full of clean water a little of the white of egg tempera; if it be quite fresh so much the better. Mix it thoroughly with the water. Take a large pencil of minever, made, as I have previously taught you, of the hairs of the tip of the tail. Take up your fine gold with a pair of fine pincers, lay it on a square piece of card larger than the piece of gold, and turned up at each corner, which you are to hold in your left hand, and, with the pencil which you hold in your right hand, wet the hole sufficiently to hold the piece of gold you have in your hand. Wet the hole equally, that there may not be more water on one part than on another; then let the gold slip off the card, taking care not to wet the card. Now, as soon as the gold has touched the wet part, withdraw the card quickly and suddenly; and if you perceive that the gold does not adhere to the panel, press it down as gently as you can with a piece of clean cotton, and in this manner gild the other parts of the panel; and when you wet it, preparatory to laying on the second piece of gold, be careful that the pencil does not go so near the first piece as to make it wet; and let the two pieces join, first breathing on it, that the gold may adhere where you wish it to unite with the other piece. When you have laid on three pieces, pass the cotton again over the first piece, and see whether any part requires mending. Provide a cushion as large as a brick, made of a smooth piece of board, covered with soft leather, very clean and not greasy, of the same kind as that of which boots are made. Stretch it very evenly, and fill the space between the wood and the leather with shreds of cloth; spread a piece of gold evenly on this cushion, and with a knife cut the gold into pieces as you want it, to make the necessary repairs. Wet the parts to be repaired with a minever pencil, and then, wetting the handle of the pencil with your lips, the piece of gold will adhere to it sufficiently to enable you to apply it on the part to be mended. When you have laid as much gold on the level surface as you can burnish in one day (for which I shall give you directions when you have to gild cornices and foliage), be careful to collect the small pieces of gold, as those masters do who are economical, so that you may save the gold as much as you can, being sparing of it, and always covering the gold you have laid on with a clean handkerchief."

"CHAP. 135.—*What stones are proper for burnishing gold.*

"When you mean to burnish gold, you must procure a stone called lapis amatisto, which I will show you how to prepare. If you have not this stone, sapphires, emeralds, balas rubies, topases, rubies, and granite, are still better for those who can afford the expense, and the finer the stone, the better it is for the purpose. The teeth of dogs, lions, wolves, cats, leopards, and generally of all carnivorous animals, are equally good."

"CHAP. 137.—*How to burnish gold, and what to do if you cannot burnish it when ready for burnishing.*

"You must now burnish gold; for the time is come that you should do so. It is true that, in winter, you may gild whenever you please, during damp and cloudy weather. In summer it will take one hour to lay on the gold; another to burnish it; but should the weather be too damp, and, from some cause or other, you are unable to burnish it, keep it in a place where it is exposed to heat and air; but if it be too dry, keep it in a damp place, always covered, and, when you would burnish it, uncover it carefully, for the smallest scratch will blemish it. Put it in a cellar, at the foot of the casks, and it will be ready to burnish; but, should you be prevented from burnishing it for eight or ten days or a month, take a very clean handkerchief or a towel, lay it over your gold in the cellar, or wherever it may be; then take another handkerchief, dip it in clean water, wring, and squeeze it very dry; open it, and spread over the first handkerchief that you laid over the gold, and the gold will then be in a proper state for burnishing."

We have here a complete account of gilding with white of egg. Further on, he gives the following recipe for another mordant:—

"A perfect mordant for walls, pictures, glass, iron, and every other thing may be made as follows: With your oil either boiled on the fire or baked in the sun in the manner before directed, grind a little biacca (white lead) and verdigris; and when you have made it flow like water, add a little varnish and boil altogether for a short time."

The varnish mentioned here is probably an oil varnish, as the varnishes described at that time are all oil varnishes. The verdigris would make it dry very quickly, and, consequently, he directs later on that no verdigris is to be added if it is not to be used at once. He also states that some fear the verdigris injuring the gold, but he has not found it do so. The rest of the directions are the same as those now given for gilding. It is of interest to note that, though he especially says the leaf must be thick for the white-of-egg gilding, he recommends very thin leaf for this gilding.

For miniature work he recommends the use of a little *gesso sottile* (one-third) mixed with a little white lead and sugar of "candia." This is made into cakes and dried in the shade. This is ground with white of egg for use. "And you must know that you may write letters with a pen dipped in this size." In another recipe he adds also a little Armenian bole.

Prof. Middleton has an illuminated MS. of the 16th century, in some parts of which the gold has come off. Underneath is a hard polished substance raised above the level of the parchment. Apparently in this case Armenian bole must have been used. Besides gold leaf, silver leaf, and tin leaf, were used. Tin leaf is recommended as superior to silver leaf, as it does not blacken. Cennino Cennini recommends the use of the tin leaf for glories of saints in wall paintings. His directions are a little obscure, but apparently it is stuck on with varnish. He also recommends gilding it before sticking it up.

This use of tinfoil is of special interest. At a later date it seems to have been used largely instead of gold, being coated with a yellow varnish called auripetrum. Several recipes for auripetrums are given in the old MSS. The Spanish leather hangings which are so famous have been prepared this way. I examined some portions of some old hangings in the possession of Mr. Cobbold, of Felixstow, and found that a design had been stamped on the leather, then it had been covered with tin leaf. Some parts of the tin leaf had been varnished with a yellow varnish and other parts painted. The rich bronze gold colour being so produced. The hanging shown has been prepared by coating canvas with size, then with gold size, and then with tinfoil. The tinfoil has then been polished and varnished with an oil varnish coloured with dragon's blood.

The recipes for the preparation of auripetrum are somewhat obscure. Several are given in the MS. of St. Andemar, which has been translated by Mrs. Merrifield. In these the oil varnish used is coloured by saffron, aloes, the inner bark of black plum, or dragon's blood. These substances are all easily dissolved in melted pine balsam, which can then be diluted with boiled oil and turps.

The re-introduction of varnished tinfoil for decorative work is, I think, to be recommended. Very beautiful and durable results are, I think, easily obtained.

Dragon's blood is easily obtainable, but varies very much in quality; the best that can be *now* obtained being sent over in sticks

about 8 inches long, each stick being encased in some native fibre. The dragon's blood in lump, as usually sold, is very inferior. The dragon's tears referred to by Charles Reade, in his essay on violins, are unfortunately no longer to be had. I know of only one sample in a herbalist's window in East London, and it is not for sale.

There is no great difficulty in having panels prepared for painting according to the method herein described, as the practices of the best gilders approach very closely to Cennino Cennini's recipes. It is perhaps not generally known that gold leaf is translucent, and that the light passing through is blue green in colour. The laying of gold on white gesso on the ground for the picture must, I think, have have had an important effect on pigments above it, corresponding to a green ground to a certain extent. Having described the preparation of the panel, we shall consider in the next lecture the preparation and properties of the pigments used to paint upon it.

Miscellaneous.

NOTES AND HINTS ON THE VEGETABLE PRODUCTS OF TROPICAL AFRICA.

By John R. Jackson.

[Concluded from page 122.]

Gums and Resins.

These may be divided into two distinct kinds, namely, the true gums which are soluble in water and form mucilage, like the Acacia gums or gum Arabic, and the hard or semifossil gums or resins, which are valuable for varnish making. The soluble gums must be looked for on the trees as they stand, and any species of Acacia may be expected to yield a soluble useful gum. Gums from different trees should not be mixed, as one kind may be of inferior quality to another, and consequently diminish the value of the better kinds. Botanical specimens should accompany these gums when sending them for report. Hard gums, or semifossil resins, are commercially known as Copal, and the very best, which is a product of Zanzibar, as Anime. This fetches the highest price of any in the European markets, and any resin approaching it in appearance should be eagerly looked after. Most of the Copals which come from the west coast of Africa are from leguminous trees, namely species of *Copaifera*, therefore allied plants should be specially looked for. All these hard resins are found buried in the ground, at varying depths, sometimes in the neighbourhood of existing trees, and sometimes on the sites of extinct forests. As illustrations of comparatively new sources from the African continent may be mentioned two recent discoveries, both in the year 1883: the first at Inhambane, where a "tract of copal forest, fully 200 miles long," was revealed, and samples of the copal, or anime, sent to England, and valued at from £80 to £100 per ton. It is known as Inhambane copal, and is the produce of *Copaifera gorskiana*. Another gum resin, known as "Ogea" gum, from the Gold Coast, was introduced to notice in the same year (1883). It is said by the natives to be used for lighting fires, and for illuminating purposes, and also as a body perfume by the women. It exudes from the trunks, either from wounds or holes caused by the boring of insects. The plant furnishing this resin is not definitely known, though it is clearly leguminous, and is probably closely allied to *Daniellia thurifera*.

Dyes and Tanning Materials.

Though the demand for vegetable dyes has, of late years, considerably decreased, in consequence of the very wide application of the coal-tar dyes, there is still a considerable amount of interest attached to new sources. Indigo is of all dyes of vegetable origin the most important. True indigo is obtained by macerating the leaves of species of *Indigofera*, chiefly *I. tinctoria* and *I. anil*, and evaporating the fluid to a thick consistence. These plants are largely cultivated in India and South America, and they are also grown in tropical Africa.

The native Yoruba indigo is obtained from a distinct plant (*Lonchocarpus cyanescens*), belonging to the same natural order. Though this dye is used in its native country, it has never been thoroughly experimented upon in England, though it might prove worth importing here as a new source of indigo.

Amongst yellow dyes to which more attention should be given than they have yet received may be mentioned the "Doundake" (*Sarcocephalus esculentus*), and the yellow dye-plant of the Soudan (*Cochlospermum tinctoria*).

It is difficult to indicate any particular natural orders of plants that are likely to yield colouring matters, as dyeing substances are found not only in widely-different natural orders, but also in different parts of the plant, as in the stems, roots, &c., and the same may be said with regard to tanning materials, though this principle is mostly found in barks and roots, and any such known to contain astringent properties should be tried for their suitability for tanning leather.

Fibres.

There is a very wide field open for the development of fibrous substances, whether for textile purposes, for rope and cordage, for brush-making, or even for paper stock. For weaving, the fibres must be very fine, continuous, and strong, and no better example of a suitable textile can be had than the flax (*Linum usitatissimum*) which, from its very

slender stem, furnishes a fibre held in the highest repute in the earliest period of the world's history, and still occupying a similar prominent place amongst the large number of fibres at present known to the commerce of the world. A very large number of tropical plants yield a fine but strong and tenacious fibre from their stems, and such must be looked for chiefly amongst plants belonging to certain natural orders as, for instance, the mallow family (Malvaceæ), sterculia family (Sterculiaceæ), lime tree family (Tiliaceæ), nettle family (Urticaceæ). Besides these there are many plants belonging to widely different natural orders which have very valuable fibrous inner barks. The presence of fibre in the barks or stems of any plant suspected of possessing it may easily be detected by cutting or breaking a piece of the stem across, and such as show a fibre should be carefully collected in sufficient quantity, say a couple of dozen pounds or so for an examination and trial at home. Again, there are many plants, such as those belonging to the pine-apple and the lily families—species of *sansevieria*, known generally as bowstring hemp, which contain valuable fibres (for rope and cordage making) in their leaves. These should command the same careful attention as those before referred to. Quite recently attention has been directed by the Governor of Lagos to a substance of which but little has hitherto been known, but which has been designated as Lagos bass. It consists of the fibres drawn from the petioles or leaf stalks of the so-called bamboo palm of West Africa (*Raphia vinifera*). This material seems likely to become an important article of trade for brush making, as a substitute for, or mixing with the true bass or piassaba from Brazil or Bahia, which of late years has been getting scarce, and consequently fetching higher prices.

A fibre that was brought to notice so recently as 1889, also by the Governor of Lagos, has been reported upon very favourably by Messrs Ide and Christy, of Mark-lane. It is known under the name of "Bolobolo" and in the Yoruba language as "Agbonrin Ilassa;" the plant from which it is obtained is *Honckenya ficifolia*, belonging to the natural order Tiliaceæ. The following quotation from the report on this fibre, by the firm just alluded to, will be of interest:—"If this fibre is capable of being produced in large quantities, there is a very wide field open to it commercially. Its market value would be regulated by that of jute, but, in our opinion, it would always command a higher price. At to-day's currencies it would sell at £16 per ton in London. We do not think the minimum price would ever fall below £12; and if the jute market made a further advance, this Bolobolo fibre might realise £20. If this fibre could be prepared of a whiter colour, it would prove still more acceptable, but even as it is, we should be very glad to see large quantities placed on this market, where they would sell readily."

Woods.

Woods may be divided into three chief divisions—namely, those useful for building or structural purposes, those used for ornamental or cabinet work, and hard woods used for turning, and particularly for wood-engraving. It can scarcely be expected that timbers or building woods can ever be brought to this country to return a sufficient profit, even if forests of any particular timber were to be opened out; it might, however, be worth transferring to other places not so far afield. With ornamental or cabinet woods, however, the case is different, for such woods, if showing any remarkable figure or colour, could be cut into thin veneers by European wood merchants, and if the trees furnishing the wood were known to exist in sufficient abundance to meet any demand that might arise, a trade might be at once established. The same may be said with regard to hard woods, and especial attention should be given to any close, even-grained wood of the character of box, the demand for which, for wood-engraving, is now so great and the supplies, comparatively speaking, so small, that it has been for some time realising a very high price. It is difficult to point to any direction where valuable woods of the character here described are to be found; but sections of any trees of a good diameter, which seem likely to produce valuable woods, should be obtained, and sent to some well known hard-wood dealer for report. Some of the best known woods of west tropical Africa is the mahogany, so-called, of the Gambia, furnished by *Khaya senegalensis*, a meliaceous tree closely allied to the true mahogany. African rosewood, from *Pterocarpus erinaceus*, and the odoom, Roko or Iroko, a wood of a bright yellow colour, furnished by *Chlorophora excelsa*, a tree closely allied to the West Indian fustic. So little is known, generally, of West African woods, or of their scientific sources, that it is most necessary that specimens of the foliage, flower, and fruit should be gathered from each tree from which the section is taken, for the proper botanical determination of the tree.

Perfumes, or Fragrant Substances.

Under this head, it is almost impossible to signalise any particular plants, or to point to any one or more natural families to which special attention should be paid. The leaves, flowers, fruits, or even seeds of some plants, possess a fragrant principle; and they have the advantage of attracting attention by the odour emitted, so that they will not fail to command notice. In whatever part of the plant the perfume resides, care should be taken to thoroughly dry that part before packing to send home, else damp and mildew may make it thoroughly worthless before it arrives.

Materials for Walking-sticks.

As this trade has now become a very large and important British industry there is necessarily a great and increasing demand for materials, such for instance as young Palm saplings, with good roots to

form the knobs or handles, or any woody plant that may exhibit an ornamental or characteristic bark. It is not necessary that the stems should be in all cases long enough for an ordinary walking-stick if the rooting portion has sufficient character to recommend it, for one of the arts of the walking-stick and umbrella-handle maker is to graft or join an ornamental knob or root on to a plain but rigid stick. Nor is it necessary for the stick to be straight, for some of the most crooked sticks are effectually straightened by heat. A few should be sent home for report, and to try whether they have any market value.

THE TOBACCO INDUSTRY OF PERSIA.

Among Persian products, tobacco holds a most prominent and important position, whether viewed from an industrial and commercial, or a social and political standpoint. The United States Consul-General at Teheran says that in its cultivation and preparation for market and transport to inland and seaport towns, large numbers of people and animals are employed. It is one of Persia's principal commodities of export, and supplies to a certain extent the bazaars of Turkey, Arabia, Egypt, the Caucasus, and Central Asia, whilst from the taxes levied upon it in the shape of customs, transit dues, and plantation tithes, the Government realizes a considerable revenue. The place occupied by tobacco in the estimation of Persia is altogether different to that assigned to it in Europe and America. In Persia it is removed from the sphere of luxuries, and held as one of the principal articles of daily necessity. An increase or reduction in the price of tobacco affects, for good or evil, almost every man, woman, or child in the kingdom. A failure of the tobacco crop would be considered as little less than a national calamity, and any cause which has the effect of raising the price of tobacco diminishes to a very considerable degree the power to purchase the actual necessaries of life. In the cultivation of the land intended for the reception of the seed great care and pains are taken to render it as suitable as possible for the germination of the seed and the gradual growth of the plant. A steady and ample supply of water is one of the most essential things in the successful cultivation of tobacco. Upon the quality of water depends also to a certain extent the delicate flavour and aroma of the leaf and its price in the market. If the water is distinctly brackish the tobacco will be mild or sweet, and its value as a commercial commodity greatly increased. If, on the contrary, the water is sweet and the soil unduly free from salacious elements, the tobacco will be rank to the taste and the odour unpleasant, and consequently of an inferior quality. The fertilizer generally used is a mixture of ashes and pigeon's dung. In order to procure an abundant supply of the latter, numerous large mud towers, having walls extensively perforated with holes large enough for the bird to roost, lay its eggs, hatch, and bring up its young in, are built on the outskirts of towns and villages and on the tobacco plantations. The seed is sown from March 1 until April 5, and this is done on prepared beds of soft mould sprinkled over with a layer of fine sand. After sowing, the seeds are lightly covered with fine sand and regularly watered every five days, until about June 1, when the plants have attained sufficient strength and maturity to admit of being transplanted. This being done, the fields are divided into squares with slightly raised embankments, and flooded. In some places it is customary, when the plant is about half grown, to make an incision in the stem, and insert one or two spikes of dried clover into the internal cavity. From these it is supposed the sap extracts a certain amount of flavour, which becomes absorbed into all the structural parts, and adds a pleasant, spicy aroma to its smoking. As soon as the plants arrive at maturity, which is usually about the end of August or the beginning of September, the harvest commences. If the leaves, after attaining a certain degree of perfection, are allowed to remain on the parent stem, they begin to change their colour, and are quickly spoiled. In order, therefore, to avoid loss, and give the plant time to develop the upper or younger leaves, the lower or first formed are gathered first. The petiole or stalk stem is carefully severed, and the leaves are laid on the ground and left in the field to get partially dried by the sun until they have changed from a green to a golden hue. As one cutting of leaves becomes sufficiently dry it is taken home, and another is proceeded with in the same manner until the whole is harvested, and nothing remains in the field but such plants as are left for seed. The process of drying or curing and preparing the article for market has to be continued without interruption and with vigilant care if the delicate flavour and fragrance of the leaf are to be retained. The leaves are hung up in every available space, and turned and re-turned with the greatest regularity. Whilst this operation is going on, such of the tobacco as has been grown with slight admixtures of alkalis is sprinkled with a weak brine, to give a pungency and flavour in the smoking, and also to preserve it from becoming musty. The tobacco is packed and pressed into sacks of coarse canvass, containing from twenty to eighty pounds each. An outer covering of the same material, to protect the tobacco as much as possible from the deteriorating effects of the air, is also added, and the whole is encased in coarsely tanned goat skins. The quality of the tobacco depends upon the locality in which it is grown, the best being that which is produced in the neighbourhood of Sheeraz and Tabaz, and the most inferior at Kashan. A large proportion of the Ispahan crop is shipped to Egypt and the Levant, as it is considered too hot or pungent for home consumption. There are three different sorts of tobacco produced in Persia. The first, called *tombakoo*, grown in Sheeraz, Ispahan, Kashan, Yezd, Tabaz, Semnan, Neharend, and Khorassan, is used only for the *kalean* or nargile, and supplies the

largest portion of the export trade. The second, called *tuttoon*, grown in Koordistan, Kermanshah, Ooroomeeyah, and other parts of Azerbaijan, is used solely for the chibouk, and is also exported in considerable quantities to Arabia, Asia Minor, and the Caucasus. The third, called cigarette tobacco—grown originally from Turkish seed, in the provinces of Ghilan and Mazanderan, on the southern littoral of the Caspian Sea—is used, as its name implies, for making cigarettes, and is, with the exception of what is consumed in Persia, exported entirely to Russia. There is also another variety, though it does not enter into commerce, grown in the vicinity of Sheeraz, and known as *duckhter peech, i.e.*, "the maiden's plait or curl," a name derived either from the resemblance of its prepared rolls to a young girl's braided hair, or because the hands of maidens are alone considered suitable to gather its delicate leaves. Tobacco, as an article of export, is found to occupy the third place in importance of the productions, both natural and manufactured, of the whole of the country. The order would be—rice first, opium second, and tobacco third. Consul Pratt says that it is his earnest conviction that not only can the cultivation and manufacture of tobacco in Persia be immensely increased, but new varieties of the plant might be successfully introduced into the country, and made to produce the most profitable results.

FARMING IN JAMAICA.

It is believed that Jamaica offers favourable openings for young men from Great Britain and other European countries with small capitals (say of from £2,000 to £3,000) and some experience in farming, who wish to adopt an agricultural career. The Governors of the Institute of Jamaica have therefore come to the conclusion that it is desirable to take some steps to bring about a means of communication between those planters and penkeepers who are willing to receive young men as articled pupils, and intending emigrants from Great Britain and elsewhere.

They have prepared a register of such planters and penkeepers as are willing to take pupils; but it must be distinctly understood that they can accept no responsibility at all in the matter, and can only circulate copies of the *précis* of the replies received from planters, from which inquirers must draw their own deductions. A form of agreement which, it is thought, might prove of service, has been prepared, but the use of it is, of course, optional.

Pupils must also communicate direct with the planters and penkeepers with respect to terms, &c.; and it is suggested that some friend should, if possible, be asked to visit the property on behalf of the pupils.

A schedule, which has been compiled from the replies (alluded to above) hitherto received from the planters and penkeepers, shows (1) the nature of the properties; (2) the districts in which they are situated: (3) the premium required; (4) some indication of the kind of home and surroundings the pupils might expect; and (5) the work they would have to perform, and the instruction they would receive. Copies of this schedule can be obtained on application to the Secretary of the Jamaica Institute Kingston, Jamaica, who will be pleased to hear from any planters or penkeepers who wish to have their names added to the register.

THE USES OF BURNT-CLAY MORTAR IN ITALY.

The United States Consul at Catania, in his last report, says that visitors to Catania invariably notice and remark on the peculiar soft pink colour of all the unpainted buildings. This colouring is the result of using cement or mortar of proved value, found in the vicinity, and which is nothing more or less than burnt clay. In the frequent eruptions of Mount Etna in times past, great beds of clay were covered and buried from twenty to two hundred feet by the lava streams, with the result, when the eruption happened in the dry season, of burning and converting these clay beds into a fine red gravel or powder. These deposits are mined, and are considered very valuable. The material, mixed with a little lime and the usual amount of water, forms a mortar or cement considered superior to any other cement for building purposes, and has been used in Catania to the exclusion of all other materials for many centuries. Every building in Catania is constructed of lava liberally cemented with this mortar. In building, small irregular stones are used, just as they happen to come, and a smooth surface is afterwards given by a thin coating of mortar inside and out, which can then be divided by a trowel to imitate blocks of stone, if desired. This burnt clay, with lime, makes a very strong and adhesive mortar; no other material would hold together the large four and six storey apartment houses, which are built entirely of small irregular stones. It also has unequalled wearing and resisting power, as the extensive harbour breakwater proves. This breakwater was built some ten years ago, and extends for three quarters of a mile out into the sea, and is said to be as good to-day as when first built. It is composed entirely of lava, and for a foot below watermark to a sufficient height to protect the shipping, of huge blocks of small lava rubble liberally cemented with the mortar. The constant wear and tear of the sea for ten years has only damaged the cement in insignificant places, and probably only where there happened to be an air space between the mortar and stones caused by faulty construction of the blocks. Consul Heath adds that the more he looks into the matter the more he is convinced of the value of this mortar as an economical substitute for all the high-priced hydraulic cements now used, and might well be adopted in other countries besides Italy.

INDIAN LAPIDARIES.

There are about 100 merchants at Cambay, India, who deal in agates, and from 2,500 to 3,000 artisans are employed there, the annual outturn ranging from £2,000 to £3,000. They make paper-cutters, armlets, jewellery boxes, and other articles of green moss-stone, white agate, and of bloodstone of red and pinkish colour. Paper-weights and rulers are made of the famous Trichinopoly marble, which is of a bluish-grey colour, hard, and takes an excellent polish. It is a cretaceous rock, consisting chiefly of well-preserved specimens of shells, with sometimes pebbles and fragments of fossil wood.

In Agra, paper-weights, knife handles, &c., are made of agate, jasper, and onyx. Plates, small boxes, paper-weights, and inkstands are made of soapstone. The manufacture of ornamental work in soapstone has been in vogue in Agra for over 30 years, and the delicacy of the carving and the beauty of the patterns have acquired for its products a very wide popularity.

The same workmen who prepare this well-known inlaid marble work are employed in the carving of soapstone articles. The lapidaries of Bhira, in the Punjab, make the hilt or handle of knives and whips, caskets, and paper-weights of the false jade or serpentine. This green, jade-like stone has not yet been assigned its proper name. It is not true jade, being much softer than that of Silesia or China; nor do authorities on the subject admit it to be plasma. It is said to be found near Kandahar, and to be brought down the river Indus on rafts, floated with inflated skins, to Attock, where it is carried to Bhira. Other stones, resembling serpentine and purbeck marble, are used as handles, and also in the fashioning of toys and small objects, such as paper-weights, by the lapidary cutlers of Bhera. There are valuable quarries near Balasore, in India, from which a description of chlorite, or black marble, is obtained, from which plates, dishes, cups, and other household utensils are made. These fetch high prices, and are much sought after.

WOOL GROWING IN ALEPPO.

Sheep are reared in very considerable numbers in the vilayet of Aleppo, and the district of Aleppo, or, more properly speaking, the mutessarrifiates of Orfa and Deir-el-Zor, are the localities where the raising of sheep and growing of wool acquire the greatest importance. In the colder districts of Marash, Aintab, Antioch, Kellis, Harem, Djesser-el-Shogr, Idlep, &c., sheep are kept in caves during the winter, and are fed on a mixture of hay and straw. The number of sheep which usually compose a flock varies greatly. Each family forms out of the sheep they possess one or more flocks, watched over by members of the family. Eighty to a hundred sheep are generally confided to one person. The United States Consul at Beyrout says, that the total number of sheep which graze in the vilayet of Aleppo is estimated by the provincial authorities at 2,500,000 in round numbers, divided amongst various tribes. All the sheep raised by these tribes belong to the breed called *Awas*, originally from Bagdad, which in crossing with other races have lost the original fineness, but gained in the length of their wool. The best wools, as regards fineness, are those coming from sheep raised by the tribes called El-Tayawi and El-Neim, who take greater care of their flocks, and give them, two months after the shearing, and several weeks apart, two or three sulphur baths, and also administer to them small doses of sulphur internally. By this treatment the sheep appear to enjoy immunity from the skin diseases which influence the beauty of the wool. Next to the wool grown by these two tribes, which is limited in quantity, comes that of the Hadidi. The process of shearing in Aleppo is of the simplest order. The sheep is laid on the ground and is shorn with common shears. This takes place from the end of April to the end of May. Each fleece is rolled up separately and is sold to the tradesmen from Aleppo, Orfa, and other localities of minor importance, who visit the encampments of the Arabs on the outskirts of the desert, where the bargains are made. The fleeces are not sold by weight but by the piece. Wool thus bought is transported to the various inland cities on camel back, and then sold to merchants and exporters. It is these latter who occupy themselves with the cleaning of the wool and with its packing in bales by hand presses. The washing of the wool is also performed by the exporter. After removing the dirt, each fleece is washed separately in a current of water. After washing, the fleeces are spread out on the grass or on stony ground and exposed to the sun. The wool from the Aleppo vilayet is mostly exported, either washed or unwashed, to the United States and to Europe, a large portion going to Marseilles. The wool from slaughtered sheep is spun by hand on common spindles, and is made into *abas*, a sort of coarse thick woollen cloak with a hood. The manufacture of these *abas*, which are used to a considerable extent in the neighbourhood is of the most primitive kind—on the old hand looms, without the employment of any mechanical contrivances. Wool is also to some extent made into carpets in this province. The wools grown in the vilayet of Aleppo are divided into seven principal classes—(1) the wool called *Hadidi*, which embraces not only the wool grown on sheep raised by this tribe, but comprises also all that produced by other tribes; (2) the wool called *Anezi*; (3) *Deir-el-Zor*; (4) *Fellahi*. These four categories are sold in the city of Aleppo, and three of them are known in Marseilles under the name of "unwashed Persian wool," the fourth, or *Fellahi*, being designated as "red Persian unwashed." When washed, they are known under the commercial name of "Aleppo washed wools." Classes 5, 6, and 7 are called respectively *Arabi*, *Barazi*, and *Milli*. The latter is by far the coarsest of these seven cate-

gories, while *Arabi* is superior even to *Hadidi*, and is known in the Marseilles market under the denomination of "unwashed Orfa." All three grades are usually to be found warehoused in the city of Orfa. Besides the varieties enumerated, wools coming from the Mardin district are also sold in the markets of Aleppo. They comprise three qualities, viz., the *Awas*, the *Caracash*, and the *Kurdes*. The first of these three is generally washed on the sheep's back by forcing the sheep to pass once or oftener through a stream of water. The *Caracash* wool is also washed by the same process, only less thoroughly. A very small per-centage of the Aleppo wools is used in the making of *abas* and carpets, and for the filling of mattresses, &c. The quantity of wool annually exported is estimated at nearly 5,000,000 pounds.

Correspondence.

TYPOLOGICAL MUSEUMS.

The following letter from Sir HENRY W. ACLAND, K.C.B., M.D., F.R.S., to Professor Flower, F.R.S., has been received:—

"Oxford,
"Dec. 15, 1891.

"DEAR PROFESSOR FLOWER,

"I greatly regret that it is impossible for me to leave Oxford to-day and attend General Pitt-Rivers's lecture. I had greatly desired to do homage to the incalculable value of General Pitt-Rivers's museum for the purposes of national education in one of its highest aspects.

"As time goes on, this value will be more and more felt. When, in face of fierce opposition, the movement for founding the Oxford museum began about forty years ago, the intention was to add to the resources of the old University an institution where, speaking generally, the facts and laws displaying the unity of the material universe could be illustrated and practically studied.

"In the biological department it was hoped so to illustrate life on our planet that the life history of the vegetable and animal world, past and present, could be studied, in whole and in part, by careful selection of types culminating in man.

"Hopeless, almost, as the task then seemed, the personal character of Phillips and Rolleston cheered it on. General Pitt-Rivers, valuing both these men and their aims, gave an impulse and encouragement which no other man could have given.

"General Pitt-Rivers made possible Rolleston's efforts to unite the study of morphology, physiology, and pathology, with that of psychology and the evolution of the races of man.

"How much this was needed, how deeply interesting the attempt, no one knows better than yourself. Oxford may yet be able through General Pitt-Rivers's museum, displayed, as it is, by the industry and ability of Balfour and the learning of Tylor, to develop a real school of anthropology, in which psychology, language, the development and peculiarities of races, will be philosophically and practically studied.

"There is yet danger that these larger views may be displaced by the present rage for technical education. For the profession of medicine we may still hope that one university may maintain a school for able men who are willing to give time to the scientific study of man, as man, prior to the detailed technical and clinical instruction in the large London hospitals. The great development of the British empire seems to demand that one university should take this position.

"Oxford has still the opportunity. The noble efforts of General Pitt Rivers will have largely contributed to this. His teaching is, in many ways, the bridge between the old and the new schools of thought. We may yet see Max Müller uniting with the modern biblical and historical enquirers, teaching in the museum with Dr. Tylor.—I am, dear Professor Flower, very faithfully yours,

"H. W. ACLAND."

Obituary.

DUKE OF DEVONSHIRE, K.G.—The Duke of Devonshire, who died at Holker-hall on Monday night, 21st inst., had been a member of the Society of Arts for thirty years, being elected in 1861. He was also a Vice-President in 1869 and 1870. His Grace was greatly interested in scientific and social progress. He was elected a Fellow of the Royal Society in 1829, and he acted as Chairman of the important Royal Commission on Scientific Instruction and the Advancement of Science. The Cavendish Laboratory at Cambridge is due to his munificence. He was one of the founders of the Royal Agricultural Society, and its President in 1869. He was also first President of the Iron and Steel Institute. In 1862 he succeeded the late Prince Consort as Chancellor of the University of Cambridge, the University thus honouring one of its most distinguished sons. The particulars of the Duke's life has been so fully recorded in the newspapers, that it is not necessary here to do more than note his connection with some of the chief public institutions of his country.

General Notes.

BULGARIAN EXHIBITION, 1892.—Information has been received from the Foreign-office, through the Science and Art Department, that the date fixed for the opening of the Agricultural Exhibition at Philippopolli, which was announced in the last volume of the *Journal* (November 13, p. 936), has been changed from 6th (18th) September to 2nd (14th) August.

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FRIDAY, JANUARY 1, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The publication of Mr. Laurie's second lecture on "Pigments and Vehicles of the Old Masters" has been unavoidably postponed. It will appear in the next number of the *Journal.*

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, by Professor John M. Thomson, Sec. C.S., on "Three States of Matter: Solid, Liquid, and Gaseous."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Chicago Exhibition, 1893.

Under date of the 27th August, 1891, Her Majesty was pleased to issue a Commission to the Council of the Society of Arts, authorising them to act as Commissioners for the Universal Exhibition, which, pursuant to an Act of Congress, and in accordance with a Proclamation made by the President of the United States of America, will be held at Chicago from May 1st to October 30th, 1893.

The Royal Commission are now prepared to receive applications from artists, manufacturers, and others desirous of taking part in the Exhibition, to afford them all necessary information, and to offer them all available facilities which they may desire for this purpose.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

As the funds granted by H.M. Government will not suffice to defray all the expenses of the Section, it is necessary that they should be supplemented by payments from the exhibitors. A charge will therefore be made to each exhibitor, based on the amount of space occupied, and calculated on the following scale:—

	Per sq. ft. s.	d.
For spaces not exceeding 100 sq. ft. ..	5	0
For spaces exceeding 100 sq. ft. and not exceeding 200 sq. ft.	4	6
For spaces exceeding 200 sq. ft. and not exceeding 300 sq. ft.	4	0
For spaces exceeding 300 sq. ft. and not exceeding 500 sq. ft.	3	6
For spaces exceeding 500 sq. ft. and not exceeding 750 sq. ft.	3	0
For spaces exceeding 750 sq. ft. and upwards	2	6

The minimum charge will be £5.

It is not expected that the total receipts from all sources will more than suffice to defray the cost of an adequate representation of British industry; but should there be a sufficient surplus after the payment of all the costs of the Section, the Royal Commission will refund the balance *pro rata* with the amounts contributed by the several exhibitors. The amount produced by the payments of exhibitors will therefore be

treated as a guarantee fund, to be expended if necessary, but if not, to be refunded to the contributors.

The Exhibition is situated in Jackson-park, within the southern limits of the city of Chicago. The principal buildings are devoted to the following main divisions:—(1) Fine Arts; (2) Manufactures and Liberal Arts; (3) Agriculture; (4) Machinery; (5) Electricity; (6) Mines; (7) Transportation; (8) Horticulture. In all these, space has been allotted to Great Britain, though it is expected that the principal British Court will be that in the Building of Manufactures and Liberal Arts, since the privilege has been conceded to this country of massing all or most of its exhibits together, should such a course prove desirable.

Exhibitors' goods will be transmitted direct in bond to Chicago, where the usual Customs examination will be made. Goods for exhibition only will not be liable to duty, but on goods sold the usual rates will have to be paid. Goods can be sold in bond, at prices independent of the tariff, the duties being payable by the purchaser.

The American railroad companies propose to carry goods back from the Exhibition free, charging the usual rates for the outgoing journey. These rates, it may be noted, are low in comparison with those usual in European countries. It is hoped that special terms for Exhibition goods traffic may be obtained from the Atlantic steamship companies. Full information as to routes, traffic, rates, &c., will be provided in due course.

A general Official Catalogue will be published in English, French, German, and Spanish. A special catalogue will also be published for the British Section.

Exhibitions of live stock will be held, and prizes will be offered in connection with them. A special circular has been issued, giving information about these.

A limited quantity of steam and water power will be supplied gratuitously. Further supplies will be provided at a fixed rate. Countershafts, pulleys, belts, &c., must be provided by the exhibitor. Application for motive power must be made on special forms, which will be supplied on demand.

The general reception of articles at the Exhibition buildings will commence on November, 1892, and no articles will be admitted after April 10, 1893. Foundations for heavy machinery may be put in, and special constructive work commenced, as soon as the state of the grounds and the buildings permits.

Special regulations will be hereafter issued for the organisation of the International Juries.

The Royal Commission are informed that the contract labour laws of the United States will not prevent exhibitors from importing foreign labour, or from entering into binding contracts with their *employés*. Further information on this head will be supplied on application.

Every person who becomes an exhibitor in the British Section thereby agrees to be governed by the rules and regulations laid down by the Exhibition Executive, or by the Royal Commission through its executive officer.

Miscellaneous.

THE TEAK SUPPLY OF SIAM.

The use of teak wood in this country has largely increased of late years, and now when builders and architects have had experience of its durability for the stairs of public buildings, rafters, beams, and such like work, there are fears of a diminution in the supply of the wood. The teak tree extends through Central and South India, Burma, and Siam, and though in the former country the plantations are placed under the careful supervision of the well organised Indian Forest Conservancy, it appears from a report on the trade of Siam, recently furnished to the Foreign Office, that the "number of years which will elapse before the teak forests in the districts become exhausted is variously estimated by the foresters and teak merchants, but twenty years appears to be the longest time allowed, and under present conditions it appears doubtful whether the supply will last so long. In ten years it may not pay to work teak unless prices rise and the method of working is improved upon, as all the timber near the streams will have been felled and dragged, and only those trees will remain which are far removed from the water, or which are near streams from which timber cannot easily be got out." Further than this, it seems that very little is done by the authorities in the way of conservancy of the forests. No young trees are planted, the natural growth of the saplings being relied upon to keep up the supply of teak; but no measures even are taken to protect the saplings from fire or to ensure their growth. Many trees are felled in a green condition, instead of being left girdled for three years until the bark falls off as in Burma.

With these conditions working adversely to the cultivation, or even to the ordinary growth of the tree, the future prospects of the teak in Siam is a gloomy one.

AGRICULTURAL INDUSTRIES OF MEXICO.

Mexico has been estimated to contain 479 square leagues of forests, 18,134 square leagues of mountain land, and 4,822 square leagues of uncultivated land. Extending through seventeen degrees of latitude, eight and a half of which are in the torrid zone, and an equal number in the north temperate zone; and, owing to its physical formation, Mexico has three well-defined climates—hot on the coasts, temperate in the regions lying at an elevation of between 3,000 and 6,000 feet above the sea, and cold in those regions lying at a higher elevation. A recent bulletin issued by the Bureau of the American Republic, says that the vegetable products of Mexico are varied in the extreme, owing to the diversified climate. Its productiveness is perhaps unsurpassed by any other country in the world. The soil produces all the cereals and all the fruits of Europe and the United States. Among the cereals, the most abundant is Indian corn, which grows almost everywhere in the country. This is eminently a Mexican staple, serving as nutriment for man and beast, and forming food for the majority of the inhabitants in the form of cakes, called *tortillas*. What are known as the hot lands (*tierra caliente*), which lie between the coast and the foothills of the Cordilleras, produce the most exuberant vegetation. Excellent grazing lands abound, studded with groups of trees, among which the trumpet-flower tree, and the turpentine, or mastic tree, predominate. Here, also, are found great quantities of gigantic bamboos, known by the name of *tarros*. Nearer the foothills lie immense forests of valuable hard woods, such as mahogany, ebony, rosewood, iron wood, &c. These forests also furnish Campeche and Brazil wood, the rubber tree, and many trees of medicinal value. Hundreds of varieties of plants, herbs, roots, &c., useful in medicine and in the industries, grow in great profusion. There are also, in many parts of the country, a great many kinds of mosses and lichens furnishing excellent dyes, among which the principal is the orchil, which grows in Lower California, and has for many years been an article of large exportation, the Mexican Government deriving large profits therefrom, as there is an export duty of ten dollars a ton. The vanilla plant grows wild in these lands, and sugar-cane is cultivated extensively in the States of Morelos, Vera Cruz, Mexico, Jalisco, Oaxaca, Tabasco, Campeche, Guerrero, and Chiapas. Coffee is grown principally in the States of Chiapas, Vera Cruz, Morelas, Oaxaca, Michoacan, and Colima, and the annual crop is valued at four million dollars. The coffee of Uruapam (Michoacan) is celebrated. Tobacco is a great product of the States of Vera Cruz, Tabasco, Campeche, Yucatan, Oaxaca, Chiapas, and Jalisco. The tobacco crop averages a value of two and a half million dollars. The great cotton-producing region of Mexico is the district of Laguna, in the State of Coahiula, which furnishes over 40,000 bales per annum. Besides this State, cotton grows in Sonora, Chihuahua, Guerrero, and Chiapas, and in several others. The annual crop is valued at nearly eleven million dollars. The cocoa bean is mostly cultivated in Tabasco and Chiapas. The best is grown at Soconusco. Chocolate sells at Soconusco for twenty cents a pound, and an excellent opportunity is said to be offered for the cultivation of the cocoa tree on a large and systematic scale. Soconusco is also the natural home of the rubber tree, but the natives foolishly chopped down and destroyed great numbers of these trees, and thereby retarded what would have become a great industry. A rubber tree once fairly started requires little or no care, and will produce the milk abundantly in from six to eight years from planting. In 1889 the Department of Public Works entered into a contract with three Mexican gentlemen to plant 15,000,000 rubber trees in the State of Oaxaca near the shores of the Pacific. The planting was to begin within eight months from the date of the contract and be finished within fifteen years, 300,000 trees to be planted the first year, and 1,000,000 each subsequent year of the term mentioned. A subsidy of three cents per tree was guaranteed by the Government, and exemption from duties on all necessary materials, tools, &c. The hot lands also yield sarsaparilla, jalap, rice, arrowroot, beans, indigo, and many other products. This region is especially rich in fruit-bearing trees, principally among which may be enumerated the orange, lemon, citron, tamarind, guava, plum, plantain, nut, and banana trees and date palms. Pineapples and melons and many other tropical fruits grow wild. The banana and the orange grow spontaneously in great abundance near the Mexican coasts. The cultivation of the orange is very profitable. One man can cultivate with his own hands from seven to nine acres of orange trees. One tree in the tropic belt of Mexico will yield as many as 5,000 oranges. Sonora is a great orange-raising district, fruit coming from the vicinity of Hermosillo in that State being highly appreciated. The colder regions of Mexico produce corn, wheat, barley, and other cereals, and the maguey or agave, from which the national drink, *pulque*, is extracted. This plant is a native of Mexico, but it is found growing in the United States, although not in any great abundance. The maguey grows on the great plains, the plateaux, at an elevation of more than 7,000 feet above the sea. It is said that as far back as 1519 the native Mexicans cultivated the maguey, of which they made many uses. A great variety of products are obtained from the roots, leaves, and juice. Paper is made from the pulp of the leaves, twine and thread from their fibre, and needles from the sharp tips of their leaves. These leaves also serve as thatching for the houses of the poor. The rare and valuable Mexican manuscripts in ancient times were made of pulp from the maguey, which resembled the papyrus. Pulque is the fermented juice of the maguey. It has been

stated that in the city of Mexico over 250,000 pints of pulque are daily consumed, and in 1888 there were 822 shops in that city devoted exclusively to its sale. Mexico is becoming a wheat-growing country, and great impetus has recently been given to growing this grain. Wheat grows on the plateaux of Mexico from 6,000 to 9,000 feet above sea level. The area best adapted for its cultivation comprises some 52,000 square miles, and is situated in the States of Mechoacan, Jalisco Guanaguato, Aguascalientes, San Luis Potosi, and Queretaro. The Mexican plan of cultivation makes it possible to take off the land three crops every two years —one crop of wheat, and two crops of Indian corn. Fibre plants grow in great profusion over nearly every portion of the territory of the Republic. Principal among them are the agave, already mentioned, the banana tree, ramie, henequen, several kinds of cacti, among which figures the organ cactus, and a species of cactus growing abundantly in the territory of Lower California, which is called *cirio*, and from which a good quality of paper is manufactured. The mulberry tree is found in many localities, and experiments lately made in the States of Vera Cruz, Puebla, Daxaca, and Michoacan in the way of cultivating the silkworm, has produced good results. As regards the methods of cultivation in vogue in Mexico, they differ but little from those employed by the ancient Egyptians. Wooden beam ploughs with a small iron shoe are used. These make a furrow five inches broad by five deep. A hoe is also used, which often weighs from three to five pounds. With the exception of a few districts, all threshing of grain in Mexico is done by driving horses or mules around in a ring upon the straw, which is on the ground. The winnowing is done by men tossing the grain and chaff into the air with shovels.

NIJNI-NOVGOROD FAIR.

The following account of the Nijni-Novgorod fair, from the last report of the Belgian Consul-General at Moscow, is quoted from the *Board of Trade Journal*:—

Before the year 1816 the fair was held at Makarieff, in proximity to the monastery of Makaire. The site for this market was badly chosen, for in spring the waters of the Volga flooded the buildings, and during the summer months the shifting sands made the transport of merchandise difficult. In consequence of the fire which destroyed the warehouses of the Makariew fair in 1816, it was decided to transfer this market to Nijni-Novgorod. A French engineer, M. de Bethencourt, was entrusted by the Government with the construction of the buildings. On a rectangular space of ground, one side of which was bounded by the Oka and the three others circumscribed by a horse-shoe canal connecting itself with the Metcherskoë lake, were erected a large number of stone buildings one storey high. To the east and west of the fair place, there have been dug galleries serving as drains, connected on one side with the Oka and terminating in the other at the semi-circular canal. These buildings cost 12,500,000 roubles. Afterwards these erections were recognised as being insufficient, and new places were erected on the other side of the canal in the direction of the Volga.

The area of the lands, buildings, &c., reserved for the fair is about 722 deciatines (deciatine = 2·7 acres).

Situated on the left bank of the Oka, this place forms a vast triangle formed by the confluence of the two rivers. It is limited on the north by the Volga and the territory of the village of Sormovo; on the south by the Oka and the Makariew quarter of the town of Nijni-Novgorod; on the east by the Oka, and on the west by the villages of Sormovo and Gardeefka. In the centre of the fair there are buildings constructed by Bethencourt, which include 60 main houses, 48 of which are placed in lines parallel with the canal, four on the Cathedral place and eight adjacent to the Palace (*Glavni Dome*).

In the course of the last two years there have heen constructed along the canal 40 large stone buildings for warehouses. On the territory of the fair there were computed to be in 1890 more than 3,000 warehouses.

On the east, at the confluence of the two rivers, there is a stretch of stone, along which two quays have been established up the Oka, the St. Petersburg quay, and up to the Volga, the Siberia quay. This place is occupied by counting-houses and the warehouses of the steam navigation companies. Near the Metcherskoë lake are the tea warehouses. The Siberia quay is connected to the Moscow-Nijni railway by a branch worked by horse traction.

Above the bridge of boats, on the Oka, which connects the fair with the town of Nijni-Novgorod is a stretch of sand separated from the bank by an extent of water from 80 to 100 metres wide. On this sandbank, which communicates with the quay by means of temporary wooden bridges, are discharged the Oural iron and the Astrakhan fish cargoes.

The Nijni-Novgorod fair, the official opening of which takes place each year on the 15th (27th) July, only enters on its period of great activity in the first fortnight of the month of August. The success of the transactions depends, to a great extent, on the yield and sale of cereals. This fair is, in reality, only a temporary market organised by the Moscow manufacturers and merchants, who dispose of their products at the busiest period of the shipping season. The articles traded in are of Russian origin, and, in smaller quantities, those of Asia and Western Europe. Among the goods in which the largest amount of business is transacted may be cited, in the first place, cotton tissues, then metals, particularly iron from the Oural works, wool and woollen tissues, &c. Camels' hair, leathers and hides, hair, feathers bristles, furs, and wool are the principal articles bought by agents on account of foreign houses.

Indigos, drugs, and pharmaceutical products, wines, and liqueurs, colonial wares, sewing machines, instruments and tools, tissues of every kind, &c., are the chief foreign articles imported to the fair by the European frontier.

The active trade in cotton tissues exercises an influence on the well-being of the working population of the governments of Moscow and Vladimir; for, by reason of the aridity of the soil, the inhabitants of the villages are not generally engaged in agricultural pursuits, but are more particularly engaged in spinning and weaving. The provinces devoted to sheep-rearing are interested in the success of the wool and woollen tissues trade. The activity of the metallurgic works of the Oural is intimately connected with the output on the Nijni-Novgorod market of iron production at remunerative prices. The population of the government of Astrakhan, which lives chiefly by the produce of the fisheries, await with interest the results of the transactions of the fish trade.

The Nijni-Novgorod fair is therefore of great importance not only to the governments of the Volga, but also to many other provinces of the Empire. This market also plays a very considerable part in the Eastern or Asiatic trade as regards the import of the products of Siberia and Asia (China, Central Asia, and Persia), as well as the exchange of these products with Russian merchandise. However, since fairs have been opened at Irbit, Tumene, and Semipalatinsk, the supplies of certain Siberian products have diminished. The Trans-Caspian railway having facilitated the development of trade with Central Asia, a very large quantity of merchandise no longer comes to the fair, and is sent directly from Moscow to the places of consumption.

The value of consignments to the Nijni-Novgorod fair in 1890 was 181,256,831 roubles.

THE INCREASED CONSUMPTION OF MEXICAN TOBACCO.

It is only since the date of the Cuban War, in 1868, that what may be termed the tobacco era for Mexico, commenced. According to the French Minister in Mexico, it is to the system of manufacture introduced by Cuban emigrants that Mexico owes the progress which has been made in this branch of national industry. The success of Mexican tobacco is now assured in Europe, and it appears to fill the gap caused by the diminished product of Cuba. Good tobacco cannot be grown everywhere in Mexico, but on the coasts and in the warm and temperate regions it may be produced in abundant quantities, and of an excellent qualtity. Such lands are rare in the world; in the first place, Europe and the United States, situated in ultra-tropical regions, can only produce ordinary leaves, suitable for very cheap cigars. Spanish America produces a slightly superior article, but up to the present the exports from South America have been insignificant, and those from Java and Sumatra consist of leaves without any aroma, and of bitter taste. The only serious competition is with Cuba, but this will, it is said, not continue very long, as that region known as Vuelta-Abajo, which produces leaves of superior quality, and which enjoys a considerable reputation, is of small extent, and the land is exhausted by half-a-century's uninterrupted cultivation. The Mexican brands of San Andrès, Tuxtla, Acayucan, and Huimanguillo, which for fifty years have only been appreciated in the country itself, are now quoted everywhere. Other and newer brands are now also celebrated. It is now no longer the practice for Mexican tobacco before going to Europe to pass through Cuba to give it a fictitious name and value. At the present day the greater part of the Mexican cigars are sold under their own name, but a considerable quantity is still put up under Havana brands. There appears to be still something wanting to the Mexican cigars. Their aroma evaporates more quickly than that of their Cuban rivals, when the box is open, one reason being that the fermentation of the leaves is incompletely carried out. Occasionally, also, a slight earthy taste is found in the inferior qualities, which would disappear if the growers would adopt the system practised in Cuba, and subject the leaves to the same treatment. However that may be, Mexican cigars are now found in considerable quantities on the markets of Antwerp, Hamburg, and London, and it is stated to be a subject of regret on these markets that the cultivation o tobacco in Mexico does not develop itself more rapidly, and that the shipments are so irregular. Up to the present it has been the want of capital that has stood in the way of this development. Magnificent lands may be purchased in the States of Vera Cruz, Oaxaca, Guerrero, Chiapas, and Tabasco, at very low prices, and on these virgin lands the cultivation of tobacco might be carried on with marked success, it is said. Manual labour is cheap, and expenses generally are much lower than in Cuba, where land is dear and taxation very heavy. At Santa Rosa (State of Vera Cruz) a hectare of land (hectare equals 2·47 acres) yields 2,000 kilogrammes of tobacco at five francs the kilogramme, a return of at least 10,000 francs (£400), and the maize that is sown after the tobacco harvest covers the expenses of cultivation. The cost of transport of a ton of tobacco from Santa Rosa to Vera Cruz is about £4, and notwithstanding the fact that the wages of the Indians employed in tobacco cultivation have recently risen, the profits yielded by this industry are enormous, the rapid fortunes realised by planters and manufacturers who have been engaged some years in this business being a proof of it. To equal the *regalias* of Havana much will have to be done, it is said, in Mexican cultivation, but the average quality of the tobaccos of Vera Cruz, Tabasco, Oaxaca, and Chiapas is already equal, and in some cases superior, to that of the Cuban article exported in bales, for the leaves of the finest quality of Cuban tobacco are bought by the Havana factories, and are used for

making cigars of the best brands. Mexico could produce more tobacco than Cuba, if capitalists in the former country only realised the extreme importance of this branch of agricultural industry.

THE WOOL TRADE IN FRANCE.

A recent report by the French Chamber of Commerce at Constantinople states that the wool production of the world amounted in 1890 to 882,576,000 kilogrammes (kilogramme = 2·204 lbs.), of which 62,652,000 kilogrammes were produced by England, 204,300,000 kilogrammes by the European continent, 146,188,000 kilogrammes by North America, and 469,436,000 kilogrammes by Australia, the Cape, and La Plata. The world's wool production was greater in 1889 than in 1890, the amount for the former year being over 926,000,000 kilogrammes. In thirty years, from 1860 to 1890, the Australian production rose from 27,000,000 to 232,000,000 kilogrammes; that of the Cape from 8,000,000 to 41,000,000; and of La Plata and Uruguay from 15,000,000 to 123,000,000. France, in 1890, consumed about 64,000,000 kilogrammes of Australian wool, representing 425,000 bales—that is to say, more than a quarter of the total production of Australia and New Zealand. The United Kingdom alone consumes a larger quantity of these wools. In 1890 the total production of La Plata and Uruguay was estimated at 130,000,000 kilogrammes, not including the wool and skins of slaughtered sheep. Of this wool France takes 64 per cent., represented by a quantity of 205,000 bales. France therefore imported in 1890 168,000,000 kilogrammes of wool in the grease or washed, of which 64,000,000 was Australian and 82,000,000 kilogrammes La Plata wool. The remainder, 82,000,000 kilogrammes, represents wool of European origin and common wool from Africa and Asia Minor. These 168,000,000 kilogrammes, with an approximate value of £14,000,000 sterling, do not, however, represent the whole quantity consumed in the country, as no account has been taken of the French clip and the wool of imported sheep. Taking all these into consideration, it may be stated that France consumed in 1890 for her industries over 240,000,000 kilogrammes of wool—more than a quarter of the entire wool production of the world.

FRENCH TRUFFLES.

The *Board of Trade Journal* gives the following particulars respecting the production of truffles, which is extracted from a report of the United States Consul at Bordeaux;—

There are three species of truffles found in France—the black and most common, the white (highly prized), and the *truffe à l'ail,* which has a flavour of garlic. They are found in all soils, but chiefly in oak forests, or where the earth is damp and calcareous, thriving best in an almost sterile soil. The best that the country affords come from Périgueux and about Angoulême.

In appearance the ordinary truffle is about the size of a walnut, with a rough, brown, warty surface, closely akin to the potato, which it likewise resembles in consistency, though not in colour. Not yielding to cultivation, they must be sought for in chance places, nor is the method of obtaining them the less interesting.

Recently it has been found that dogs could be trained to perform the duties that are instinctive to the pig, and so great is the demand in France for the truffle that many of the canine species are now, in certain districts, possessed of this estimable talent. Finely cut or sliced truffles are mixed daily with their food, until at length they develop a liking for the flavour. Afterwards their owners conceal, in some portion of a field where truffles are supposed to exist, a little tin dish of *filet aux truffes*, covering the same with a few handfuls of earth. The dog is then brought out and urged to hunt for the dish, goaded by an empty stomach. When he at length finds it, he is caressed by his master, and thus, in the space of a few weeks he will readily learn to hunt for the vegetable itself.

Truffles are seldom found twice in the same place. A field that may yield a great quantity this year will be quite fruitless the next. Though Alexander Bornholz, a German scientist, claims to have transplanted and raised the article in question, repeated experiments to that end have proved but failures. The Count de Noá, a Frenchman, and a certain M. Rousseau, made like claims, but they have in each case been discredited.

The very fact that the truffle is a rarity, and that it grows only in certain districts, has been enough to make it an object sought after clandestinely by peasants or those who carry them to market. There are poachers for truffles as well as for game, who hunt by night with their dog or pig, a plague to landowners and a *bête noire* to local gendarmes.

Scarcely is there a canning establishment at this moment in France that does not, among other alimentary products, preserve this dainty. It has become as indispensable to the dinner table of the *noblesse* as the aromatic sprig of garlic to the frugal repast of the peasant.

The annual production is valued at about 3,000,000 dollars. The article is sold in the departments where found at 1 dollar per pound and at almost double that price at the principal markets of the larger cities. Not alone does the truffle thrive in France; they are found in quantities in Italy, Spain, and Holland, but are of indifferent quality compared with the French, lacking the delicate and incomparable flavour of the native product.

In the United States, especially in California, some attention has been given, within the past few years, to the gathering and preserving of truffles, and a number of Western packers have come to Bordeaux in

order to inform themselves regarding the canning process. It is a very simple one, the truffles being partially boiled, as tomatoes, asparagus, and other vegetables, and then jarred and sealed in their own diluted juice. All meat and game products are also "truffled," the vegetable being cut into small squares, and inserted into the substance of the article preserved.

In 1889 the imports of truffles into France were 22,585 lbs., and the exports therefrom 452,361 lbs. Of the latter quantity, 204,633 lbs. went to England, 107,276 lbs. to Germany, 38,990 lbs. to Belgium, and 24,387 lbs. to the United States.

MANUFACTURING INDUSTRIES OF SPAIN.

Consul Turner, of Cadiz, says that, although Spain does not figure among the leading manufacturing nations of the world, it cannot be denied that during the last few years great advancement in the development of this branch of industry has been made. Already her manufactures of chemical and pharmaceutical products are very important, and also those of paints, varnishes, and prepared cloth for artists, made at Madrid, Leon, and Barcelona. Among others, are the soaps of Seville, Cordova, Toledo, Madrid, Valladolid, and Saragossa; the candles of Madrid; the fertilizers of Huelva, Alicante, Haro, Barcelona, and Madrid; the matches of Tarragona, Aragon, Saragossa, Vittoria, Guipuzcoa, Madrid, and Leon; the syrups and essences of Seville, Granada, Barcelona, and Madrid; the syrups, acids, chlorides, sulphates, &c., of Madrid, Barcelona, Alicante, and Leon. There is a national manufactury of small arms at Toledo, of firearms at Oviedo, and of cannon in Seville and Trubia. Among the private industries, those worthy of notice are the establishments for the manufacture of arms at Toledo, cutlery at Albacete and Saragossa, and firearms at Eibar, Plasencia, and Oviedo. In Madrid, Barcelona, and Valencia surgical and astronomical instruments are manufactured. Musical instruments are made in Barcelona, Madrid, Valencia, Seville, Valladolid, Saragossa, and other cities. The clarionets of Salamanca, the flutes of Huesca, Teruel, and Valencia, and the banjos and guitars of Cadiz are famous. In Madrid and Barcelona very good pianos and organs are made. There are, in Spain, many paper factories, the best being those of Barcelona and Tolosa; of ordinary paper at Caravaca; of pasteboard at Gerona, Burgos, and Loix; of cigarette paper at Alcoy, Cocentayna, Onteniente, Bocairent, Bilbao, Valladolid, Segovio and Catalonia; of wall paper at Madrid and Barcelona. The principal centres for making furniture are Madrid, Barcelona, Cadiz, Vittoria, and Pontevedra. In the ceramic industry, Seville, Gijon, and Barcelona are distinguished for the production of fine opaque china, porcelain, tiles, &c. There are important manufactures of crystals and glasswares in Segovia, Malaga, Corunna, Carthagena, Barcelona, Bilbao, Oviedo, Guadalagara, and Saragossa; of gold, silver, nickel, and white metal goods in Madrid, Barcelona, Cordova, Saragossa, and Salamanca; and the finish of the steel goods of Madrid, Toledo, and Eibar is without rival. Most of the hemp of Spain is exported, but some of it is used in the manufacture of matting, among which that of Crevillente is well known. The canvas made of this hemp is used in the manufacture of shoes, and is an industry of some importance in Southern Spain. The manufacture of cotton goods, which is almost confined to Catalonia, is constantly growing. The principal factories are located in Barcelona, Mataro, Esparraguera, Sans, Granollers de Valls and Villanueva y la Geltru. There are others of less importance out of Catalonia, such as those of Valladolid, Saragossa, Cavada, Malaga and Guipuzcoa. The manufacture of knitted goods is confined to Barcelona, Mataro, Esparrayuera, and Reus. The manufacture of woollen goods has six principal centres—Catalonia, Alcoy, Bejar, Ezcaray, Antequera, and Palencia. In Caceres, Toledo, and a few other cities, there are also factories of some importance. The principal silk factories are in Valencia and its province, and in Murcia, Seville, and Almagro. Cork factories are found in the provinces of Caceres, Badajoz, and Gerona. Hats are made in all parts of Spain. Boots of all kinds are manufactured extensively in Barcelona, Saragossa, and Madrid; gloves in Seville, Cadiz, Saragossa, Barcelona, Madrid, Zamora, and Burgos; fans in Valencia, Barcelona, and Madrid; and leather goods generally in Madrid, Malaga, and Salamanca. There are extensive dry docks for shipbuilding at Bilbao and Cadiz. Both are private enterprises, but they have been well patronised by the Spanish Government. There are in Spain several other very important yards, some of which are under Government control. Consul Turner says that, judging by the amount paid to the Government for the right to engage in manufacturing enterprises, the most important provinces in Spain are Madrid, Barcelona, Valencia, Seville, Saragossa, Malaga, Cadiz, Gerona, Granada, and Alicante. It should be borne in mind that nearly all of the industries mentioned above are small and primitive, and in only a few are modern methods followed, or modern machinery used.

INSECT PLAGUES IN EGYPT.

In a recent report by the British Vice-Consul at Alexandria, it is stated that the plague of locusts which has been devastating Morocco has been extending itself to Egypt. Some little time ago, clouds of locusts made their appearance and settled, for the most part, on the banks of the Nile or on the edge of the desert, forming large yellow patches,

easily discernible at a distance. They at once began to breed, and, although immediate steps were taken to destroy them, large numbers of the eggs have already been hatched. An examination of about thirty deposits of eggs is said to have shown that the usual number laid by each female is from ninety-seven to a hundred. The Government at once issued the strictest orders to the mudirs to use every possible means to destroy the locusts, and competent officials were sent round the country to organise and direct the work of extermination. Millions of locusts and eggs have been destroyed, but there are still large numbers in the country. When eggs are discovered, either the field is ploughed up or flooded, or the eggs are collected and destroyed. The old locusts are easily destroyed while breeding, but the young crickets, in the earliest stage, when they are hopping about in every direction, give more trouble. The usual method followed in this case is to enclose the spot in which the crickets are found by a number of men drawn up in the form of a crescent. A ditch is then dug from one horn of the crescent to the other, and the men close in, driving the young locusts, by means of palm branches, into the ditch, where they are destroyed and buried. When the young locusts are further developed, they cease to hop, and march in densely packed armies. It is at this stage that they are said to be most destructive, but they are more easily exterminated, as they move slowly, and can be surrounded with fuel and burned. From the energetic measures taken by the Government, it is hoped that this pest may be stamped out before any serious harm has been occasioned, but as many eggs are still known to be deposited in the country, it is impossible to foretell the extent of the calamity, and it is possible that many eggs are being hatched in the desert. Up to the present time it is reported that little damage has been done to the cotton crops, but it is difficult to obtain any reliable information on the subject. The system employed in Cyprus for the destruction of locusts has been adopted in Egypt when practicable. Another insect plague, in the shape of a repulsive-looking scale insect, made its appearance in Alexandria some time ago, and last year committed great ravages in the gardens adjacent to the town, attacking trees, shrubs, and the fruit of the date palm. Various measures have been tried, but the only efficacious one appear to be that of cutting the branches and carefully brushing the boughs. Unfortnnately, however, no general regulation has yet been put into force, and consequently the efforts of some individuals are nullified by the apathy of others, and the plague still continues and threatens to spread throughout the country. The insect has been classified as *Crossotoma Ægyptiacum*, and was probably imported from America. It is popularly known as *cotonina*, from its resemblance to cotton. A decree has now been issued, prohibiting the transport of trees and shrubs from Alexandria to other parts of the country.

THE AGRICULTURAL PRODUCTS OF MALAGA.

Consul Newson, of Malaga, says, in his last report, that the superficial area of the province of Malaga measures 1,837,197 acres, of which about a third is devoted to the cultivation of wheat, barley, maize, corn, *garbanzos* (chick peas, an important article of home consumption and of exportation), beans, and rye. An extent of 282,180 acres is under grapes, and 104,007 acres under olive trees. Other large areas, embracing many acres, are given up to the cultivators of the orange, lemon, *chirimaya* (a species of apple), fig, plum (ten varieties), cherry, (five varieties), mulberry, pomegranate, banana, apple, peach, pear, walnut, chestnut, lime, *prisco* (a species of peach), and apricot. Of late years, the almond tree has received considerable attention, as there is a great demand for the nut, principally in the United States and England. The grape vine lands of the province, once the source of so much prosperity, have, for several years past, greatly deteriorated in value, hundreds of acres having been devastated by the phylloxera. The vineyard districts of the province are now reduced to two prominent varieties of grapes—the Pedro Ximen and muscatel—although many other varieties are grown in small quantities. Other classes have totally disappeared, chiefly owing to the ravages of the mildew and phylloxera. During the years 1888–90, the loss was very great, to such an extent that the exportation of raisins from the consular district of Malaga alone fell from 641,835 boxes in 1866 to 70,456 boxes for the fiscal year ended June 30, 1891, being a decrease of 571,379 boxes in four years. At Denia, about 320 miles from Malaga, on the Mediterranean, the grape is extensively cultivated, and is rapidly coming into competition with the Malaga market. While the article is not so good as the muscatel, yet the rapid process of curing permits their export at a much lower price, and much earlier than from Malaga. In the former district the grape is dipped into hot lye, and it is a raisin in a few days, while in Malaga it takes a fortnight to cure the muscatel. The process of converting grapes into raisins is very simple. When the grapes are thoroughly ripe, they are picked in bunches, with their stems, and laid upon boards with wooden frames, slanting at an elevation of 45° towards the west, or on sandy ground, sloping so that the afternoon sun can be utilised. Coarse cloth is used to cover them at night, in order to keep off any dew. The grapes are turned over from time to time, until, at the end of two or three weeks, they become raisins, some appearing on the stems just as the branches come from the original stock, while others are picked from the stems, and packed singly by hand into boxes. The muscatel grape, while making the largest raisin, is very delicate, and will not bear transhipment. The vines are usually planted eight feet apart, and are never trailed, but are permitted to grow as bushes, not reaching,

ordinarily, over four feet in height. They are cultivated by keeping the grass out from between the rows and the soil loose. The bunches are sometimes turned towards the sun while growing on the vine, to ripen the fruit which hangs in clusters near the ground. The Denia grapes are dipped in hot lye, as already stated, and hence are cured much more quickly than other grapes, but present a less attractive appearance than the Malaga variety. The lemon, though an important article of export, is not so valuable as the lemon of Italy, Portugal, or Brazil, or even Mexico, and the quantities shipped have considerably fallen off, chiefly owing to competition from abroad, and to the ravages of the disease among the trees, known as the *serpeta*, or *pulgon* (blight), which consists of a gummy substance which oozes from the trees and exhausts their vitality. Orange trees are sometimes afflicted with the same disease as that which attacks the lemon, and yet they appear not so much affected by it. The almond trees grow almost anywhere without cultivation. They are to be found growing on the almost perpendicular sides of mountains, on the tops of mountains, in the valleys, in fields, and apparently out of the rocks. The olive is one of the oldest trees in the province, some of the trees in the district of Malaga having reached the age of from three hundred to five hundred years. They are generally small, and most of them have only part of the trunk of the tree left, while new branches shoot out from the deformed body and bear the fruit. The fig tree is a prolific bearer, and produces two kinds of fruit in the season—one following the other—from the same tree, and the figs are said to be excellent. The tree has a large fine leaf, and is considered healthy and hardy.

THE SWISS CHEESE INDUSTRY.

Cheese-making is the most important agricultural occupation in Switzerland, as upon it depend the prosperity of the milk industry, the rearing of milch cows, and the value of pasture-land. The country is not adapted to the fattening of cattle in sufficient numbers to supply the wants of the population, and the Swiss consumer is to a great extent dependent on foreign countries for meat. There is a brisk business in sending young cattle to fatten on the other side of the frontier, and in re-importing them. According to a recent British report from Berne, during the past year 326,506 animals of all kinds, of a total value of £2,440,239, were imported into Switzerland, while 71,930, value £649,440, were exported. Austria-Hungary, France, and Italy supplied the greater number of the cattle imported for slaughter, while those imported from Germany were rather for farming purposes. The total export of cheese last year amounted to £1,528,288, and of condensed milk to 529,797. The price of cheese rose during the year, owing to a deficient supply caused by the difficulty of obtaining milch cows in sufficient numbers. Swiss milch cows are in great demand in Germany, and the fact of their exportation to that country, coupled with the increased quantity of milk required by the condensed milk factories, hampers the development of the cheese industry. The best market for Swiss cheeses is France, where the hard Emmenthal cheeses are much sought after, the total value exported to that country in 1890 amounting to £426,564. Germany and Austria import the soft and juicy Emmenthal cheeses, while those imported by Italy are, for the most part, of an inferior quality. The question of the duties levied by foreign countries on Swiss cheese is one which naturally occupies an important place in the negotiations for the renewal of the Swiss commercial treaties. The following are the duties at present in force:—France, 3s. 4d. per 100 kilos. (the octroi duties varying from 8s. to 12s.); Italy, 6s. 8d.; Germany, £1; United States, £1 12s.; Austria-Hungary, 8s. 4d. The prospect of an increase in these duties, such as that contemplated by the new French tariff, is regarded with much apprehension, as it will be felt by the whole milk industry.—*The Times.*

CORK TRADE IN SPAIN.

The following notes on the condition of the cork trade in Spain are quoted in the *Board of Trade Journal* from the monthly *Bulletin* of the French Chamber of Commerce in Barcelona:—

In examining the strips of Catalonian cork, irregularities are observed which render certain of the elementary operations of the industry difficult. This is the more unfortunate because the cork trade is relatively prosperous, and constitutes the sole occupation of a great number of the inhabitants of the north-east of the province of Gerona. It is precisely to these irregularities, which occur in a much less degree in the cork of Andalusia, Estramadura, and Portugal, that the Catalonian cork workers owe their reputation as skilful artisans. This reputation is well deserved, if we consider the difficulties which they have to overcome to obtain a good return from the cork of their country.

An approximate estimate, and no other can be obtained, gives an annual consumption of 400,000 quintals of cork in Catalonia. Of these, 200,000 are produced in the province itself, 150,000 are brought from other parts of Spain, and 50,000 from abroad. The value of the total amount is estimated at twelve million pesetas, and the expenses of the manufacture of corks, package, and transport, amount to eight million pesetas more. The eight millions of expenses are thus divided:—

Breaking off and scraping the strips, 400,000 pesetas; squaring the cork, 2,000,000; manufacture of corks, 3,500,000; selecting and packing, 1,400,000; and transport of the strips to the factories and of the

bales of corks to the ports of shipment, 700,000. Total cost, 8,000,000 pesetas.

If we analyse the previous operations we find—

1. That 400,000 quintals of cork produce 1,400,000 corks of all sizes, that is to say, 3,500 corks per quintal.

2. That 1,400,000 corks have produced a sum of 20,000,000 pesetas, that is to say, 1,428 pesetas a thousand, expenses and profits included.

If we analyse the expenses of manufacture, taking the quintal as the base of our calculation, we discover the following figures:—

Boiling and scraping the strips, 1·00 pesetas; squaring, 5·00; manufacture of the corks, 8·75; selection and packing, 3·50; and transport, 1·75. Total of the cost per quintal, 20·00 pesetas.

The province of Gerona exports annually an average of 46,670 bales. This represents approximately, as we have said above, 1,400,000 corks. Of these bales, 14,283 pass through the Custom-house of Palamos, 16,723 by that of San Feliu de Guixols, 12,669 by that of Portbou, and 2,999 by that of Barcelona. There are manufactured, in our region, thirty-two different kinds of corks, classified according to their length and diameter, from the homeopathic cork of 22 mils. for 5 or 10, to the *bretas* of 64, for 45 or 55 mils., and their price differs from 1 to 50 pesetas a thousand. These prices obtained at the factory, which vary to an infinite degree according to the purity and the quality of the cork out of which they have been made, can only be considered as general, and susceptible of modification according to locality and circumstance.

There are 8,228 individuals employed in the different factories; these are divided into nine categories, namely, *taponeros*, or corkmakers proper; *cuadradores*, whose business is to square the cork; *raspadores*, who remove the first bark from the strip; *escogedores*, who choose the corks; *blanquedores*, or bleachers; *calibradores*, who arrange the corks in accordance with their size; weavers; spinners; and carders. The men whose business it is to boil the cork, to square it, to choose it and to classify it, usually earn a fixed salary of 3 pesetas a whole day. Those who make the corks, working for so much a thousand, earn from 18 to 20 pesetas a week, and sometimes 25. But there are others who, unfortunately, make from 5 to 6 pesetas a day. The men engaged in transporting the goods earn 2·50 pesetas for the whole day.

Corks enter free of duty into England and Norway. Since the passing of the MacKinley Tariff, the exportation of Spanish corks to the United States has absolutely ceased. The *trefinos* corks for champagne, and the small corks of the same best quality, having been well paid for, the proprietors of oak-cork are now selling their strips at a price at least 3 pesetas higher than during 1889 and 1890. It is therefore to be hoped that the cork industry will continue to prove prosperous in spite of foreign competition, of the MacKinley Tariff, and of the altered conditions of the Republics of South America, which last have closed a market which was already considerable, and which seemed likely to increase in importance.

Notes on Books.

A HAND-BOOK OF INDUSTRIAL ORGANIC CHEMISTRY. Adapted for the use of Manufacturers, Chemists, and all interested in the utilisation of Organic Materials in the Industrial Arts. By Samuel P. Sadtler, Ph.D. Philadelphia: J. B. Lippincott Company.

The author says that his endeavour has been to bring within the compass of a single volume an account of the more important chemical industries, or groups of related industries, written in language that may be understood by those not specially trained in chemistry. He further states that, "in taking up the several industries for survey, it has been thought desirable, first, to enumerate and describe the raw materials which serve as the basis of the industrial treatment; second, the processes of manufacture are given in outline and explained; third, the products, both intermediate and final, are characterised, and their composition illustrated, in many cases, by tables of analyses; fourth, the most important analytical tests and methods are given, which seem to be of value either in the control of the processes of manufacture or in determining the purity of the products; and the fifth, the bibliography and statistics of each industry are given, so that an idea of the present development and relative importance of the industry may be had." The various industries are dealt with in the following order:—(1) Petroleum and mineral oil industry; (2) industry of the fats and fatty oils; (3) essential oils and resins; (4) cane-sugar; (5) industries of starch and its alteration products; (6) fermentation industries; (7) wine, spirits, bread making, vinegar, and milk industries; (8) vegetable textile fibres, paper making, gun cotton, collodion, celluloid, &c.; (9) textile fibres of animal origin; (10) animal tissues and their products, leather industry, glue and gelatine manufacture; (11) industries based upon destructive distillation; (12) artificial colouring matters; (13) natural dye colours; (14) bleaching, dyeing, and textile printing.

A HAND-BOOK OF BRITISH COMMERCE: being a Descriptive and Statistical Account of the various Articles forming the Import and Export Trade of the United Kingdom. By P. L. Simmonds. London: Moffat and Paige.

This little work contains an account of the various articles of commerce, arranged in alphabetical order from *abaca* to *zinc*, and in each entry is given particulars as to source of supply, and amount of imports and exports. There is at the end of the book

an alphabetical table of the general imports of the United Kingdom in 1890, with the quantity and value of the principal articles received.

THOMAS SOPWITH, M.A., C.E., F.R.S.: with excerpts from his diary of fifty-seven years. By Benjamin Ward Richardson, M.D., LL.D., F.R.S. Longmans, Green and Co.

Mr. Sopwith, the eminent civil engineer, who died in 1879, left behind him a very extensive diary; from this Dr. Richardson, who was an old friend of Mr. Sopwith, has compiled an interesting memoir, in which the particulars of a long and active life are related, and particulars are given of many distinguished men with whom the subject of the memoir came in contact. The many radical changes that have occurred in the manners of the people, and the modes of locomotion during the greater portion of the present century, are also alluded to in these pagef. Mr. Sopwith was a member of the Society of Arts, from 1843 until the date of his death.

General Notes.

ALGERIAN WINE. — During the year 1890, 57,289,733 gallons of wine were produced in Algeria from an area of 263,000 acres. The estimated value of the wine is £2,300,000, and more than half of that produced is sent to France.

SCHEVENINGEN SPORTING EXHIBITION. — An International Sporting and Fishing Exhibition, including horses, is to be held at Scheveningen, near the Hague, in the summer of 1892, under the patronage of the Queen of the Netherlands. Baron A. N. F. M. van Brienen du Groote Lindt, of Wassendar, is Commissary-General of the committee appointed to organise the Exhibition.

CHICAGO EXHIBITION.—The moving sidewalk at the World's Fair grounds was opened to the public on November 25th. About 300 representive men went by special train from Chicago to inspect this novelty. One of the criticisms made of this means of transportation was with reference to the danger to old men, ladies, and children, but experience from a week's use of the road shows that there is no trouble in this respect. The speed is so slow that there is no difficulty in getting on or off. This exhibit is on a wooden trestle 25 ft. high, the sharpest curve having a radius of 75 ft. The sidewalk is 900 ft. long, having 360 deg. of curvature in that length. When hauling about 350 passengers, which is about one-third of the capacity of this experimental line, the additional power expended is about 2½-horse power over and above that necessary to move the walk. The *Railroad Gazette* says:—The Road is now in full operation, and is carrying a large number of passengers. A full view of the World's Fair grounds is obtained from the seats of the cars.—*The Engineer.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 20.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention." Sir FREDERICK BRAMWELL, D.C.L., F.R.S., will preside.

JANUARY 27.—F. W. EDRIDGE-GREEN, M.D., "The Scientific Value of Lovibond's Tintometer."

FEBRUARY 3.—T. PRIDGIN TEALE, "Dust, and How to Shut it Out."

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

Papers, the dates of reading of which are not yet fixed:—

"Iceland." By TEMPEST ANDERSON, M.D.

"Ancient and Modern Art Pottery of Japan." By ERNEST HART.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

JANUARY 12.—ERNEST SATOW, C.M.G., "The Laos States of Upper Siam." Sir THOMAS WADE, G.C.M.G., K.C.B., will preside. 4.30 p.m.

FEBRUARY 16.—LEWIS ATKINSON, "The Kimberley Exhibition."

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru."

Papers, the dates of reading of which are not yet fixed:—

"Australasia." By Sir EDWARD BRADDON, K.C.M.G.

"Newfoundland." By Sir WILLIAM WHITEWAY, K.C.M.G.

INDIAN SECTION.

Tuesday afternoons, at 4.30 p.m.:—

JANUARY 21.—HERBERT JONES, "From Tien-Shan to the Pamirs—experiences on the Russo-Chinese Frontier." The paper will be illustrated by lantern slides.

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-General Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

JANUARY 26.—WILLIAM MORRIS, M.A., "The Woodcuts of Gothic Books." Sir GEORGE BIRDWOOD, K.C.I.F., C.S.I., LL.D., M.D., will preside. The paper will be illustrated by lantern slides.

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets."

MARCH 8.—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE T. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.
January 25, February 1, 8, 15.

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.
February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.
March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bateriolology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by PROFESSOR JOHN M. THOMSON, Sec. C.S., on the "Three States of Matter: Solid, Liquid, and Gaseous," on Wednesday evenings, January 6 and 13, 1892, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 4...Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. Boverton Redwood, "The Gallician Petroleum Industry."
Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. C. H. Bedell's paper, "Party and Party-fence Walls."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Dr. Hill, "From Reflex Action to Responsibility."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. Du Maurier, "Social Pictorial Satire."

TUESDAY, JAN. 5....Royal Institution, Albemarle-street, W. 3 p m. Prof. J. McKendrick, "Life in Motion, or the Animal Machine."
Pathological, 20, Hanover-square, W., 8½ p.m.
Zoological, 3, Hanover-square, W, 8½ p.m. 1. Dr. J. Anderson, "A small Collection of Mammals, Reptiles, and Batrachians from Algeria." 2. Mr. F. E. Beddard, "The Earthworms collected by Dr. J. Anderson in Algeria." 3. Mr. R. I. Pocock, "Some Myriododa and Arachnida collected by Dr. Anderson in Algeria and Tunis." 4. Mr. Oldfield Thomas, "The Species of the Hyracoidea."

WEDNESDAY, JAN. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Juvenile Lecture. Prof. J. M. Thomson, "The Three States of Matter—Solid, Liquid, and Gaseous." (Lecture I.)
Geological, Burlington-house, 8 p.m.
Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. T. Charters White, "Photo Micrography."
Archælogical Association, 32, Sackville-street, W., 8 p.m.
Civil and Mechanical Engineers, 7, Westminster Palace Hotel, S.W., 7 p.m. 1. General Meeting. 2. Mr. R. Bolton, "The Square Drilling Machine and its Uses."

THURSDAY, JAN. 7...London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ernest Pauer, "Judgment of Musical Works."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. G. McKendrick, "Life in Motion, or the Animal Machine."

FRIDAY, JAN. 8 ... Astronomical, Burlington-house, W., 8 p.m.
Geologists' Association, University College, W.C., 8 p.m. Mr. Horace W. Monckton, "The Geology of the Country round Stirling."
Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, JAN. 9 ... Botanic, Inner Circle, Regent's-park, 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. G. McKendrick, "Life in Motion, or the Animal Machine."

Journal of the Society of Arts.

No. 2,042. Vol. XL.

FRIDAY, JANUARY 8, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

Professor J. M. THOMSON gave the first of his course of Juvenile Lectures on Wednesday evening, 6th inst., the subject being "Three States of Matter: Solid, Liquid, and Gaseous." Professor Thomson said that in the first lecture the general common properties which may be observed in the three states of matter would be considered. A short general description of the different states of matter was then given, the three conditions and the change from one to another being experimentally illustrated. The lecturer then pointed out that no strict line of demarcation could be found between the three conditions, and showed the intermediate viscous condition as illustrated by flowing pitch and plastic substances.

After showing the effect of temperature and pressure in producing the changes in the conditions of matter, the special properties of solid bodies were described, these being illustrated by experiments dealing with the elasticity of different substances, their fusibility and infusibility, and the various capacities of certain substances for conducting heat and electricity. Reference was next made to the changes which certain substances show in occupying an allotropic condition, and, in certain cases, undergoing change in colour without changing their composition. Some of the special properties of liquids were then described, including the different expansions by heat—the question of the different pressures exerted by their vapours. The production of cold by the rarefaction of air was beautifully illustrated by Mr. Fleuss, with his new pump. In this experiment water was frozen by a few strokes of the pump.

Professor Thomson then spoke of the passage from gaseous to liquid conditions, and showed how cold was produced by the evaporation of liquefied gases, using, as an illustration, liquefied carbonic acid gas. Reference was then made to the diffusion of liquids, and to the power which certain substances possess of passing through membranes in the process of dialysis. Passing to the special properties of gases, the lecturer illustrated his remarks by experiments showing the diffusion of gases into each other, and the different rates of diffusion belonging to different gases.

Professor THOMSON will deliver the second lecture of the course on Wednesday next, the 13th inst., at seven o'clock. This lecture will be devoted to a consideration of the different changes that may be observed in the action of various material substances on each other when in different states.

FOREIGN AND COLONIAL SECTION.

The first meeting of the Section for the present Session will be held on Tuesday afternoon, 12th inst., at 4.30 p.m., when a paper on "The Laos States, Upper Siam," will be read by Mr. ERNEST SATOW, C.M.G.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

The first meeting of this Committee was held on Monday, 4th inst. Present:—Sir Frederick Leighton, Pres. R.A. (Chairman of the Committee), Philip H. Calderon, R.A., Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., F. Seymour Haden, F.R.C S., Sir James D. Linton, President of the Royal Institute of Painters in Water Colours, Walter William Ouless, R.A., Edward J. Poynter, R.A., Lumb Stocks, R.A., Marcus Stone, R.A., W. Hamo Thornycroft, R.A., H. Stacy Marks, R.A., and Sir Henry Trueman Wood, Secretary of the Royal Commission.

TRANSPORTATION COMMITTEE.

The first meeting of this Committee was held on Wednesday, 6th inst. Present:—B. Francis Cobb, in the chair, Sir Nathaniel Barnaby, K.C.B., C. V. Boys, F.R.S., Henry Chapman, James Dredge, Francis Elgar, LL.D., Walter H. Harris, Charles Holmes, George N. Hooper, with Sir Henry Trueman Wood, Secretary of the Royal Commission.

Proceedings of the Society.

CANTOR LECTURES.

PIGMENTS AND VEHICLES OF THE OLD MASTERS.

By A. P. Laurie, M.A.
King's College, Cambridge.

Lecture II.—Delivered December 7th, 1891.

PART I.

Palette of Cennino Cennini.

In the first lecture we have dealt with the preparation of panels for painting, with gilding, and with the use of tinfoil and coloured varnishes. The recipes are similar to those at present in use, and if equally good and durable results are not obtained, it seems to be due more to want of care and of taking time than to serious defects of method. We come next to the consideration of the pigments used during the best period of art, with the view of carefully examining their nature and properties. Here we are met by several difficulties.

In the first place, we are embarrassed by the number and variety of pigments mentioned. I cannot attempt to deal with more than a few of them in a short lecture, and must select those of apparently the most importance. In the next place, it is in many cases difficult to identify an old pigment, or to recognise the same pigment under different names. Much ingenuity, however, has been expended on this subject, and, on the whole, with tolerably satisfactory results.

In the third place, a large proportion of the old pigments are fugitive, and we are consequently somewhat embarrassed by this fact, as it throws upon us the burden of picking out those of real value from among the many described.

It is of importance, in this connection, to remember the various uses to which the pigments were put. Roughly, these may be described as, painting in fresco, painting in secco on walls, painting in secco on panels, painting in oil, and illuminating MSS.

Now, of these, the most destructive to pigments is fresco painting, and consequently few pigments could with safety be used, while, on the other hand, many pigments might safely be used for illuminating that could not be used for anything else. Protected from damp and from the action of light, preserved between closed leaves of vellum, and probably never touched by sunlight, many fugitive pigments might be safely used.

It is, furthermore, impossible to consider this subject of the durability of pigments by itself, apart from the mediums used to paint with. When we come to consider the question of vehicles, we shall find that certain pigments may safely be used with some vehicles that cannot be used with others. There is another very pertinent question that can be asked, How many of the old works of art have perished completely from natural decay? Are not those we possess the successful experiments among many failures? It is a common remark to say of an Old Master that it is as fresh as the day it was painted. There are very few that really have this appearance. If carefully examined, the colours have, in many cases, dulled and faded. The pigments still look bright owing to their contrast one with another, though often, when examined separately, they appear quite dull.

Unfortunately, too, there are pigments which, while quite legitimate under old conditions, are no longer suitable for use in the polluted air of modern cities. It is also of importance to consider climatic conditions in this connection. For instance, it is an easy problem to paint permanent pictures in the dry climate of Egypt, a very difficult one to do the same in England. All these matters have to be taken into consideration, giving us a very complex problem to be dealt with.

Let us begin by considering the list of pigments mentioned by Cennino Cennini. This list we can add to afterwards, but it forms an important and useful introduction. They are as follows:—

Red.—Sinopia (red ochre), cinabrese (red ochre and white), cinnabar, minium, amatisto (hæmatite), dragon's blood, lake.

Yellow.—Ochre, giallorino (Naples yellow), orpiment, risalgallo (realgar), zafferano (saffron), arzica.

Green.—Verde terra, verde azzurro (copper green, malachite), verderame (verdigris).

White.—(Chalk) bianco sangiovanni, (white lead) biacca.

Blue.—Azzurro della magna (azurite), azzurro oltre marino (ultramarine).

Black.—A soft black stone. Black made of the tendrils of young shoots of the vine. Black made of the skins of almonds, or the kernels of peaches. Lamp black.

Let us take these pigments in order, and consider them one by one.

Sinopia.—This is one of the many names under which red ochres are mentioned, whether native or prepared by roasting yellow ochres. They have been used from the earliest times, and are perfectly reliable for all kinds of work. There is no need to dwell longer on them.

Cinabrese.—This pigment is described by Cennino as being a mixture of red ochre with chalk. This is very commonly done now in order to prepare a bright red, and is a perfectly harmless practice.

Cinnabar (vermilion).—This pigment is known in two forms, native and artificial. Cinnabar, or sulphide of mercury, is one of the commonest ores of that metal, and is occasionally found in pieces of a fine red colour when ground. Probably it was first used in this form. A much finer pigment is, however, obtained by subliming sulphur and mercury in a covered crucible, when the cinnabar is found at the top in crystalline masses. This method of preparation must have been known from very early times.

The preparation of mercury is described by Theophrastus, 300 B.C., and the early alchemists, such as Geber, were familiar with many of the compounds of mercury, so that there can be little doubt that they were also familiar with the artificial preparation of vermilion.

The oldest of the MSS. on the preparation of pigments, that of Theophilus, supposed to be of the 12th century, describes the preparation of artificial vermilion; and similar recipes occur repeatedly in MSS. of later dates. Returning again to Cennino, there can be no doubt that the vermilion he refers to is artificial. He says:—"This colour is produced by alchemy, performed in an alembic. . . You may find many recipes, especially among the friars. . . Always purchase whole cinnabar. . . That which is convex on the top, and covered with needle-shaped filaments, is the best." It has been suggested more than once that the old masters used the native cinnabar, but, on the whole, the evidence is, I think, against this view. Evidently Cennino, at any rate, was familiar with the artificial variety.

No people have been more famous than the Chinese for the preparation of vermilion, and they still have a deservedly high reputation for it. It seems to have been used by them, from very early times, as a royal colour; and we find, according to Marco Polo, that the paper currency of Kublai Khan was stamped with the royal signature in vermilion. This remains the custom to the present day in China. The Chinese prepare the vermilion now by subliming sulphur and mercury, and then grinding, washing, and floating over. According to an account published recently in the *Chemical News*, the vermilion is suspended in water containing a little size. In this it settles slowly, and the top layer is then removed. I have examined many samples of vermilion from China. It is a little difficult to get the genuine article, as most of that sent in here is merely European vermilion repacked in Chinese paper. The real article is unmistakable. It is not quite so bright as English vermilion, but is of a finer and softer colour, and is much more finely ground, being as soft as silk between the fingers. On subliming it, an ash is left, weighing from ·1 to ·05 per cent., or even less, of the whole. The ash is brown, and is apparently a trace of oxide of iron.

Unfortunately, English vermilion makers have departed from the ways of their forefathers. They prepare a product by heating the black sulphide of mercury with strong caustic potash, and the product is seldom free from alkali and alkaline sulphides.

Chinese vermilion may be safely mixed with white lead. I know a sample so mixed which has remained unchanged for 40 years. I should not like to try the same experiment with many of the vermilions made here.

You will ask, is vermilion a permanent colour when properly prepared? This question is somewhat difficult to answer, but I will give you my view of the matter.

In the first place, let us consider the facts before us. Vermilion is a sulphide of mercury. Now this sulphide can exist in two varieties, the red or vermilion and a black sulphide. We can pass from the black to the red sulphide. We can also, unfortunately, pass very easily from the red to the black sulphide. If Chinese vermilion (that is practically the same article as Cennino describes) is ground in oil, painted out, and exposed to sunlight in a south window, it *turns black in a few months*. This agrees with Cennino's statement:—"But remember that vermilion is not durable when exposed to the air; it is more lasting on pictures than on walls, because, by long exposure to the air, it becomes black when applied to walls."

Evidently, then, Cennino distrusted this pigment, though I venture to differ with his reason for doing so. We know of too many pigments that are affected by air or moisture. The case of vermilion seems to be different from these. No chemical change is needed. The action

of the sun's rays alone seems to re-arrange the molecules into the black variety. In the experiments on water-colours made by Captain Abney and Professor Russell, it was proved that, while many so-called fugitive colours were permanent in dry hydrogen, this did not save vermilion from turning black.

Now, let us look at the evidence on the other side. I have already mentioned the experiment with vermilion in Mr. Holman Hunt's studio. But we can get other examples. There are many reds in the National Gallery that can only be produced by vermilion. Among others, look at the red in the "Rape of Helen," Benozzo Gozzoli, 1420—1498 (591).

How, then, are these apparently contradictory facts to be reconciled? If we accept the theory put forward by Abney and Russell, that the rate of destruction of a pigment is a function of the amount of light falling on it, and that, consequently, a feeble light for 100 years produces the same effect as a strong light for one year, we cannot reconcile these facts. But this opinion of theirs has not been accepted by the best authorities, such as Prof. Church; nor does it agree with the experience of chemists in other directions. Let us take, as an example, the action of heat in assisting chemical change. There are some changes which take place at a gradually accelerating rate, as the temperature is raised, but there are others which do not begin until a certain temperature is passed. My own opinion is, that vermilion is a case of this kind; that it does not change in the diffused light of a room, but is quickly altered by direct sunlight. In this way only can I account for the facts before us. Under proper conditions, then, vermilion, properly made, is, I believe, a reliable pigment, and may be safely used. European vermilions, unless carefully washed with weak acid, and then with water, are not reliable. In this way 70 per cent. of the ash is removed.

Minium or Red Lead.—This pigment, prepared by the careful roasting of litharge, has been long known. It is described by Pliny, and, according to this authority, was discovered 320 B.C. There can be no doubt that this pigment has been much used in the past, and it is still very largely used for house-painters' work. It is, however, very rarely used by artists, as it has fallen completely into discredit. To my mind there is no more beautiful red, and I think it is a great loss to the palette. Two reasons for not using it are usually given. One, that it tends, like all lead pigments, to blacken in impure air. The other that it is actually decomposed by daylight, returning to the dull brownish-yellow litharge. It is of interest here to note what Cennino Cennini says of it:—"This pigment is only proper to be used in pictures; for if it be used on walls, on exposure to the air, it suddenly becomes black, and loses its colour." It used to be customary to wash it before use with wine and water. One curious recipe for preserving minium is given by De Mayerne, a physician in the Court of Charles I., to whom I shall have to refer more than once in my next lecture. He advises washing it repeatedly with vinegar. More than one reference shows that it was not considered a very safe pigment. It was prepared by roasting white lead. It is now, I believe, usually prepared from litharge. No doubt the minium prepared from white lead would be a finer pigment. I have not made any experiments with it myself, but I propose doing so, as I doubt if it is rightly condemned, and its beauty makes it well worth reintroducing to the notice of artists.

Amatisto.—There seems to be considerable doubt as to the nature of the pigment so called by Cennino Cennini. He says it is a natural colour, and is produced from a hard firm stone from which burnishing tools can be made. It is a purple colour, and is probably a variety of hæmatite. (Mrs. Merrifield seems to think it may have been native cinnabar.) One curious point is that Cennino says it is the colour that cardinals use. "The cardinals had the red hat by a decree of the Council of Lyons, held in 1245 by Innocent IV. They did not adopt the red dress till 1464, that is under the pontificate of Paul II; therefore at the period when Cennino was living they still wore the purple colour" (Tambroni).

Dragon's Blood.—I have already referred to this resin in the first lecture. It is mentioned by Pliny, and is the resin obtained from the calamus palm. (*Pterocarpus Draco.* Linnæus.) Dragon tree. Cennino says of this pigment, "Let it alone; it will never do you much credit."

Lake, which comes next in order, I shall treat of at the end.

Yellow ochre.—Nothing need be said about this pigment. A natural earth, it has been used from the earliest times, and is absolutely permanent. Cennino describes a very fine variety he found near Casole.

Giallorino.—The history and nature of this pigment is somewhat obscure. Cennino distinctly states that it is a volcanic product. He

states that it is not a brilliant yellow though brighter than ochre, and never makes bright greens. Mrs. Merrifield considers that several pigments were included under this name. I cannot do better than quote her summing up of this matter.

1. "A native mineral yellow pigment, known by the name of *giallolino*, *giallolino di Napoli*, *jaune de Naples*, *luteolum Napolitanum*."

This is doubtless the yellow referred to by Cennino. All trace of it seems to be lost, though probably a proper search in a volcanic district would lead to its discovery.

2. "An artificial pigment which was composed of the yellow protoxide of lead, and which was called *giallolino*, *giallolino fino*, *giallolino di fornace di fiandra*, *luteolum Belgicum genuli* (the last is a Spanish term), and *massicot*, of which there were two varieties, namely, the golden or yellow, and the white or pale *massicot*."

This pigment can be prepared by gently roasting white lead. It is now known as Turner's yellow. It is apt to turn black, like all lead pigments, the fault of our towns, not of themselves.

"3. An artificial pigment made at Venice, composed of *giallolino fino* and a certain kind of *giallo di vetro*, or vitreous yellow, for which a recipe is given in the Bolognese MS. in the Venetian dialect, and which appears to have been the Hornaza of the Spaniards."

This recipe is worth quoting, and is as follows :—

"To make yellow glass for paternosters or beads: —Take of lead 1 lb., of tin 2 lb.; melt and calcine them, and make glass for paternosters.

"To make *giallolino* for painting :—Take 2 lb. of this calcined lead and tin, that is, 2 lb. of this glass for paternosters, 2½ lb. of minium, and ½ lb. of sand pounded very fine; put it into a furnace and let it fine itself, and the colour will be perfect."*

This pigment must have been a yellow lead frit. Probably effective on fresco walls, but of little or no use in oil. Mrs. Merrifield then goes on :—

"I consider it established that they used two kinds of Naples yellow, namely,—

"1. A native mineral pigment found in the neighbourhood of volcanoes, the nature of which is not accurately known, and which was called 'giallolino di Napoli,' and 'jaune de Naples,' and which is synonymous with the first kind of giallolino above mentioned.

"2. An artificial pigment now in use (?) composed of the oxides of lead and antimony, called 'giallo di Napoli,' 'jaune de Naples,' and Naples yellow, and which was not known to the old Italian artists."

Apparently the manufacture of the more modern artificial Naples yellow has now ceased. I failed to find either that it was made or that anyone had ever heard of its being made in Naples. The manufacture has long ceased apparently. The colour now sold as Naples yellow is, I understand, usually a mixture of yellows. One sample I examined was massicot pure and simple. A fine yellow can be made from lead and antimony, and I have some here which I have made myself. Possibly a search on Mount Vesuvius might result in the rediscovery of the original Naples yellow.

Orpiment or Auripigmentum.—This sulphide of arsenic exists both as a natural and artificial pigment. The natural sulphide is found in volcanic districts. It has not been found in any of the ancient Greek or Roman paintings. Cennino says it is unfit for use in distemper, because it turns black. Cennino mentions it as being an artificial pigment. It was known and used through the best periods of art, but always with special precautions, as being liable to change and to attack other pigments.

Cornelius Jansen says, "Orpiment will ly fayre on any colour except verdegris, but no colour can ly fayre on him; he kills them all."

De Mayerne, speaking of Vandyck, says :— "He makes use of orpiment, which is the finest yellow that is to be found, but it dries very slowly, and, when mixed with other colours, it destroys them. In order to make it dry, a little ground glass should be mixed with it. In making use of it, it should be applied by itself, the drapery (for which alone it is fit) having been prepared with other yellows. Upon them, when dry, the lights should be painted with orpiment; your work will then be in the highest degree beautiful."

This addition of powdered glass is advised by Cennino for another reason. It will be noted, from these accounts, that it does not seem liable to alter in itself, but to act on other colours. If it was liable to change, it would be advisable to use some different medium than oil. There can be no objection apparently to using it in the way stated, but it would not be safe to put it into the hands of a modern artist, as he would probably mix it too freely with other colours. The reason for not painting it over with verdigris will be given when we come to that pigment.

* MS. of the 15th century in the library of the R. R. Canonica Regolari, in the Convent of the St. Salvatore in Bologna.

Risalgallo Realgar, or Red Orpiment.—This pigment, prepared by heating gently orpiment, has similar properties, and must be used with the same precautions.

Zafferano (Saffron).—Cennino recommends preparing this colour by putting the saffron in a bag and rubbing it down with lye. He says it is good for staining linen or paper, and it makes a beautiful green with verdigris, but must not be exposed to the air. This is of course a very fugitive colour, and was probably only used for temporary purposes. Saffron has already been mentioned as suitable for colouring varnishes.

Arzica.—Cennino says that this pigment is not durable when exposed to the air, and is not to be used on walls. According to the Bolognese MS., it is a lake prepared from weld (wild mignonette). It is probably the most permanent of the yellow lakes. When used for dyeing, weld yields a very beautiful yellow, which stands exposure to sunlight remarkably well, and is probably the most permanent yellow dye. It is used by William Morris for his tapestry work. At the same time the yellows in the old tapestries do not seem to bear exposure and time so well as the reds and blues. In many cases they are almost completely gone. So that Cennino's judgment of this pigment is probably correct.

This completes the list of yellow pigments mentioned by Cennino Cennini. He has, however, omitted one of the first importance from the list, to which he devotes a great part of his book, namely, gold. He describes elsewhere the grinding up of gold leaf for use in miniature painting, and as his panels are laid on with gold, he depends on it for many of his effects. The use of gold as a yellow pigment, however, apart from decorative work, is not common, as far as my experience goes. It is, however, used by Holbein, the process being apparently to lay on the gold, and then glaze with dull yellow up to the high lights, just allowing the gold to show through at the high lights. Another remarkable instance is the famous rainbow portrait of Queen Elizabeth. The inner lining of the robe is a rich yellow. The high lights are given by means of gold.

Those who have not tried do not know what a wonderfully rich effect can be produced by the glazing over gold of transparent pigments.

Verde Terra (Terra Verte).—There is no need to say anything about this natural earth. Like the ochres, it is useful and absolutely reliable, and always has and always will be used. Cennino says that it may be used instead of bole for preparing the surface for the gold.

Verde Azzurro.—Cennino says that this green is prepared from Azzurro della Magna. He also states that it must not be ground too fine, as it loses its colour. According to Mrs. Merrifield, however, Verde Azzurro is a native copper carbonate, similar to green bice. Cennino's description certainly suggests a frit of some kind, as the frits are spoilt by too fine grinding. It is not impossible that the azzurro della magna (blue copper ore) was converted into a green pigment artificially. There can be no doubt, however, that green copper ores were known and used as pigments. I shall, however, discuss this point at greater length when I come to the copper blues.

Verderame (Verdigris).—Of this pigment Cennino says it is good in pictures tempered with glue, but must be never mixed with white lead. He also says it is improved in colour by grinding with vinegar, but is not durable.

This pigment was largely used apparently both by the Italian and Flemish painters. It was prepared by exposing plates of copper to the action of acetic acid vapour, and it is a sub-acetate of copper. A finer preparation was made by dissolving it in vinegar, and letting it crystallise out. This preparation was known as *verde eterno.* It is a very transparent blue green, and was used to glaze over other colours. A drapery, for instance, painted in yellow and glazed with verdigris, would be of a fine green. I have tried to illustrate this hue, but not altogether successfully. It is possible, however, that the verdigris is somewhat at fault. The green is, however, a fine one, especially as no yellow brighter then ochre is used in the solid painting. Verdigris is perhaps the most interesting of all the pigments used by the old masters, as we know it to turn black and to invade and destroy other colours. Its successful use by them, therefore, is little short of marvellous. I will treat of this, however, at some length when the mediums used by the old masters come under discussion, and it will be our most interesting example of what can be done by the right selection of a medium.

Bianco Sangiovanni (Whitening).—This is merely whitening, or chalk, and is recommended for fresco work by Cennino Cennini. His method of preparation is, however, a beautiful one, He takes slacked lime, and mixing it with water, keeps it for eight days, changing the water every day. He then makes it into small cakes, and lets them dry in the sun. As he says, the older they are (that is,

the more complete they change back into carbonate) the whiter they become.

Biacca (White Lead).—Cennino says that it must not be used for fresco, as it turns black, but may be used on pictures. This pigment was apparently known to the ancients, though not used on walls. It always has been, and still is prepared (some of it) in the same way, by the action of vinegar vapour on metallic lead; a process popularly known as the Dutch process. There is no reason to suppose that the pigment made now by this process differs in any way from that used by the old masters. It is absolutely essential for oil painting. It may be as well to explain here, and now, certain points about this pigment which seem to be not clearly understood by artists.

In the first place it is necessary to understand that stack lead, as I shall call it, that is white lead made by the action of acetic acid vapour on lead plates, contains two substances, one known as carbonate the other hydrate of lead, and it owes its peculiar properties to the intimate union in the right proportion of these two. One of the most important of these properties is its power of combining with the oil, to form what is known as a lead soap, thus forming a leathery substance of great durability. All the so-called permanent whites do not do this, and, consequently, remain merely a mixture of particles of pigment with the oil. Furthermore, a great deal of white lead is made now by a precipitation process. It is whiter than stack lead, and therefore preferred by artists; but it does not combine with the oil, as stack lead does, and is not so reliable. A mixture of the two is also sold, which is fairly satisfactory, I think.

Now, to illustrate what I mean by this combining with the oil, I will describe an experiment made by a manufacturer of whites. He coated some pieces of canvas with different whites, such as patent white, precipitated white lead, and so on, and fixed them up on a roof, where they would flap about in the wind, and get all the weather going. The stack lead canvas was not affected by this treatment, but the other whites cracked and dusted off. I am now repeating this experiment, as I think it a very important one. Whatever may be the result, there can be no doubt that stack lead was used by the old masters.

To go on to another point—the darkening of white lead. In impure air, containing certain compounds of sulphur, white lead turns to an unpleasant brown. If, however, it is then exposed to sunlight, it quickly recovers again and returns to its original white.

Besides this action, if kept in the dark it becomes of a yellow colour, not disagreeable. This is quite different from the effect of sulphuretted hydrogen, but can also be removed by exposure to sunlight.

The ease with which white lead is thus restored has not, I think, been allowed for sufficiently in considering its instability as a pigment.

Azzurro della Magna.—Cennino says of this blue that it may be used in fresco. According to Mrs. Merrifield, it is a blue copper ore. Cennino says that it is found in the veins of silver mines, and that it comes from Germany and from Greece. There was, probably, no blue more universally used than this during the best periods of Italian Art. It is repeatedly referred to, and Professor Branchi, of Pisa, has found it in many old pictures and frescoes. I do not doubt that blue often seen on the walls of our cathedrals, where a little of the old colouring remains, is this copper ore. It is true that the original preparation of copper blues seems to have come in also very early, and it is difficult, therefore, to say which may have been used in any particular case. I will not trouble you with all the information collected on this point. With reference to the use of copper blues in painting, however, a few remarks are necessary. In the first place, it seems to have been the practice to lay on this blue with size and not with oil, the opinion being that in oil it turned green. Whether this is so or not is deserving of an experiment. In order to be able to use size in an oil painting, the oil surface was rubbed with a little garlic. In this way a sticky surface was formed on which the size can grip. The use of size in this way is undoubted, and has been found in restoring some ancient pictures. Doubtless, also, the blue would be laid on with *certain* varnishes, but this point must be left in the meantime. After laying on with size it was varnished over in many cases.

In fresco, of course, these difficulties would not present themselves. Copper blue and green have fallen into great discredit in modern times, and I propose to consider here shortly how far this is justifiable.

In the first place, their use in oil seems to have been always objected to, certain varnishes or size being used. But if used with size or in fresco there seems to be no reason to doubt their durability in pure air. Copper tends,

under certain conditions, to oxidise and carbonate into blues and greens, as is seen on old bronze. This is the final product from exposure to damp and air, and doubtless a stable one. The fact of similar colours being found in copper ores, confirms the view that copper blues and green, at any rate of native origin, should be stable compounds.

Can they then be recommended for use now in fresco painting. I fear not, and because of our old enemy, sulphur. In the pure air of a country church, where gas has never been heard of, I would not fear to use them, but they are, I consider, more susceptible even than white lead, and for this reason. White lead is easily restored, at least in oil, by exposure to sunlight. Copper, I believe, will be found not to recover in the same way. It will gradually blacken without recovery. Consequently the re-introduction of copper ores for fresco work cannot, I fear, be recommended.

There was another very interesting copper pigment known from the earliest times, which is not mentioned by Cennino Cennini, and which was known as smalt. The modern smalt is a cobalt blue, which is wanting in durability, though it would doubtless be easily prepared so as to be absolutely permanent. The old smalto, smalt, and the artists' cobalt blue, all belong to the same class of pigments, that is, they are rough glasses, or frits as they are called. The modern smalt is so composed that it decomposes very easily. Now two substances can be used to colour these frits, cobalt and copper. How far back the use of cobalt goes for this purpose does not matter at present. The use of copper from very early times is well known. These copper frits were largely used by the Egyptians, and they seem to have been famous for their preparation. Sir Humphry Davy analysed a lump of this copper frit from Pompeii, and found its composition to be —carbonate of soda 15, silica 20, copper 3.

Vitruvius says (vii. 11.) mix copper filings, alkali, and finely ground sand, make into balls with water, and fuse in a glass furnace.

An interesting paper in the *Comptes Rendus*, No. 108, was published a short time ago by F. Fouqué on this Egyptian blue. It is too long to quote here.

Professor Russell has made many experiments on it, and I have here some of his preparations. The interesting result of his work is, that he has produced a whole series of shades from purple to green. The knowledge of this preparation must be very old, as the streak of green colour on the fragment of coffin lid given me by Prof. Middleton was evidently a frit. It consisted of some transparent green fragments, and was unaffected by the reagents that would have at once changed a copper ore. As this lid was about 1500 B.C., the use of these frits is taken back to a very early period.

They are quite useless in oil, as fine grinding immediately destroys their beauty, but are, I believe, especially applicable to fresco work. I know of no blue at present in the market which can be safely recommended for fresco painting, and I think that these blues might well be revived for this purpose. The manufacture of a cobalt frit or common smalt might well be improved, so as to make a reliable pigment of it.

Azzuro Oltre Marino (*Ultramarine*).—We now come to the most famous of all blues, real ultramarine, prepared from lapis-lazuli. Cennini says, "Ultramarine is a colour more noble, beautiful, and perfect than any other colour; and its good qualities exceed anything we can say in its favour." The utmost pains used to be taken with its preparation from the stone, and it was always very expensive. Certain monasteries were famous for preparing it, and supplied it to the artists they employed; and many stories are told of their stingy ways with this colour, and how they suspected the artists of stealing it, and so on. It is still prepared, but has been replaced by the artificial ultramarines. These are similar in chemical composition, and very beautiful, and the best qualities seem durable. But it is very questionable if they equal in any way the real article. I quote in full Cennini's description of the method of preparing this colour. It is very similar to the recipes given in other MSS.

"CHAP. 62.—*Of the nature of azzurro oltre marino* [*ultramarine blue*], *and how it is prepared.*

"Ultramarine blue is a colour more noble, beautiful, and perfect than any other colour, and its good qualities exceed anything we can say in its favour. On account of its great excellence, I shall speak of it at length, and give you full directions for preparing it; and you must pay great attention to them, for they will bring you honour, and be of much service to you. And with this colour and gold (which are the great ornaments of our art) you may produce the finest effects. First take some lapis lazzari; and if you would know how to distinguish the best stones, take those which contain most of the blue colour, for there is mixed with it what is little better than ashes. That which contains least of these ashes is the best. But be careful that you do not mistake for it azzuro della magna, which is as beautiful

to the eye as enamel. Pound it in a covered bronze mortar, that the powder may not fly away; then put it on your slab of porphyry, and grind it without water; afterwards take a covered strainer, like that used by the apothecaries for sifting spices, and pound again as much as is required. But bear in mind that, although the ultramarine becomes finer the longer it is ground, yet the colour is neither so rich nor so deep; and that the fine sort is fit for miniature-painters, and for draperies inclining to white. When the powder is prepared, procure from the apothecary's six ounces of resin of the pine, three ounces of glue (*mastrice*), and three ounces of new wax to each pound of lapis lazzari. Put all these ingredients into a new pipkin, and melt them together. Then strain them through a piece of linen into a glazed basin, add to the mixture a pound of the powder of lapis lazzari, mix it all well together into a paste. And that you may be able to handle the paste, keep your hands always well anointed with linseed-oil. This paste must be kept at least three days and three nights, and must be stirred a little every day; and remember that you keep it for fifteen days or a month, or as long as you please. When you would extract the azure from the paste proceed thus. Prepare two sticks, with handles neither too thick nor too thin, about a foot long; let them be well rounded at the end and polished. Then, your paste being in the glazed basin into which you first put it, add to it a porringer full of lye, moderately warm; and with these two sticks, one in each hand, turn and squeeze, and mix the paste thoroughly, exactly in the manner that you would knead bread. When you see that the lye is perfectly blue, pour it out of the glazed basin; take the same quantity of fresh lye, add it to the paste, and stir with the sticks as before. When the lye is become very blue, pour it into another basin, and add more lye, as before. When this lye is very blue, pour it into another glazed basin; and continue to do so as long as the lye is tinged with colour. Then throw it away; it is good for nothing. Range all the basins before you on a table, in the order in which they were drawn off—that is to say, the first, second, third, and fourth—then, beginning at the first, with your hand stir up the azure, which, by its weight, will have sunk to the bottom; and then you will know the depth of the azure colour. Decide how many shades of the azure you will have, whether three, or four, or six, or what number you please, always remembering that the first-drawn extracts are the best, as the first porringer is better than the second. And if you have eighteen basins of extract, and you wish to make three shades of azure, take the contents of six basins and mix them together; that will be one shade. Proceed in the same manner with the others. But remember that if you have good lapis lazzari, the azure from the first two extracts is worth eight ducats the ounce. The last two extracts are worse than ashes. However, your eye must be accustomed not to spoil the good azure by mixing with the bad; and each day remove the lye, that the azure may dry. When it is quite dry, put it into skins, bladders or purses, as may be most convenient."

PART II.

On the Lakes used by the Old Masters.

The success in the production of permanent pictures by the great painters of Italy and Holland, encouraged me to inquire into the pigments used by them, with a view to assisting the modern artist in his selection of pigments and methods of painting.

As the subject is a very large one, I have begun by selecting the lakes for inquiry, and propose to state here the results of my investigations into the methods used to prepare such pigments, reserving an account of the methods of using them for the next lecture.

By lakes I mean pigments prepared by staining, or dyeing, a white powder or precipitate with vegetable or animal colouring matter. They have been used for painting from the very early times, but they are of very unequal permanency, and often fade or change in colour.

I found on beginning the inquiry that a considerable amount of material existed to form the basis of experimental work.

It seems to have been customary to collect and write down recipes for the preparation of colours and directions for using them, and consequently MSS. exist, some dating as far back as the 13th century, and some bearing the names of men known to be in communication with the best painters of the time, which contain a large amount of detailed information, which has been brought together by modern writers in a convenient form. Besides Eastlake's "Materials for the History of Oil Painting," we have an English translation of the manuscript of Cennino Cennini (15th century), by Mrs. Merrifield, and a translation of the manuscript of Theophilus (13th century), by R. Hendrie.

The most valuable of all is Mrs. Merrifield's "Ancient Practice of Painting." Mrs. Merrifield was sent out in 1845, by Sir Robert Peel, to inquire for and collect such manuscripts, and has edited and translated several in the work referred to above.

There are other works of older date than these, such as the "Arte Vetraria," by Neri (1612) and "L'Art de Teinture," by Hello (1701).

For information as to the colours used in

classical times, I am indebted to Prof. Middleton, who has collected into his article for the new edition of the "Dictionary of Antiquities," all that is known of the Egyptian, Greek, and Roman pigments, and has kindly allowed me the use of the proof sheets.

I have, however, confined the inquiry to a period dating roughly from the 13th to the 17th century, and have collected from manuscripts within that period seventy-four separate recipes for the preparation of lakes. Most of these, however, are merely repetitions one of another. The earliest method of preparing lakes seems to have been the staining of white earth, with the coloured juice of a flower. Prof. Middleton says that this was a method used in Rome, and some lake evidently prepared in this way was found at Pompeii. Accordingly we find in the oldest manuscripts with which we have to deal recipes of this kind.

For instance, a recipe for the preparation of lake in this way occurs in the manuscript of Eraclius, which is regarded as not being later than the 13th century:—

"Thus when painters wish to imitate sil atticum they put dried violets into a vase of water over the fire to boil, and when boiled down they are strained through a linen cloth, and rubbed down in a mortar with chalk, and so a colour like sil atticum is made."

Again we find Eraclius says:—

"Flores in varios qui vult mutare colores,
Causa scribendi quos libri pagina poscit,
Est opus ut segetes in summo mane pererret,
Et tunc diversos flores arteque recentes."

NOTE.—The above quotations are taken from Mrs. Merrifield's translation of the manuscripts of one "Jehan le Begue," notary to the masters of the mint in Paris, who compiled them (1431) from the manuscripts of one "Jehan Alcherius." They contain the recipes collected by Jehan Alcherius himself, and also the manuscripts of S. Audemar of Eraclius, and part of that of Theophilus. Mrs. Merrifield has corrected the version of Eraclius, and the manuscripts of Jehan le Begue by the copy of Eraclius bound up with Theophilus, and found by Raspe in Trinity College Library, Cambridge, now at the British Museum (Egerton Manuscripts, 184 A).

"Inveniet properetque sibi decerpere eosdem,
Cumque domum fuerit, caveat ne ponat in unum,
Illos, sed faciat quod talis res sibi poscit
Desuper equalem petram contriveris istos
Flores; incoctum pariter tum contere gypsum,
Sic tibi siccatos poteris servare colores.
Ex quibus in viridem si vis mutare colorem,
Calcem commisce cum floribus; inde videbis
Quod tibi mandavi, veluti prius ipse probavi."

It will be seen that when a purple colour is required, a neutral substance is used; when a green, lime is added. The colour in the former recipe is consequently green.

In order to use the colours thus prepared for illuminated manuscripts, they were mixed with a little gum arabic or white of egg beaten up, directions for this occurring frequently. I have prepared a green pigment by boiling the petals of violet with water, filtering and evaporating the filtrate slowly with a little French chalk and gum arabic.

The result shows that such pigments can be prepared with no great difficulty, and would doubtless give soft and pleasing tints.

Eraclius gives also another method of preparing lake by allowing ivy juice to slowly evaporate in a porous jar till thick enough to use as a colour.

DE EDERA ET LACCA.

"Propositis rebus edere satis utile robur.
* * * * * *
Vere novo, reduci cum gaudent omnia succo,
Arboribusque repert humor, ...
* * * * * *
Nam subula rami, loca per deserta forati,
Emittunt viscum, quem qui sibi sumpserit illum,
Transferet in rubeam coctum prurigine formam;
Sanguineumque sibi leviter capit ille colorem,
Hunc sibi pictor amat et scriptor diligit eque.
Hinc etiam roses fit parcia tincta colore.
Quæ quoque caprinas, quæ pelles tingit ovinas."

The preparation of a lake from ivy is also described by S. Audemar.* He advises the addition of madder straining through a cloth, and then evaporating over a fire. "And while it is on the fire, put it frequently with a twig upon your rod to try it. If it is thick enough, let it cool and harden, so that you may be able to make it into cakes."

In this recipe he says take lac, that is, the gum of ivy; and in other recipes the month of March is mentioned as the right time to collect the gum from the young twigs. This gum is referred to in Balfour's "Manual of Botany," and is stated to have certain medicinal properties, but it is not mentioned in the "Pharmacopœia," and the wholesale druggists know nothing of it. I have not been successful in preparing such a lake from the young twigs of English ivy—the expressed

* Supposed to be not later than the end of the 13th century. Contains some recipes from Clavicula. A 12th century MS.

juice merely drying up into a dark green—but I have obtained a yellow gum from the ivy in Italy, which, on exposure to air, darkens gradually to a ruby colour on the outside. Apparently, however, to get a fine colour from it, the Italian sun is necessary.

We soon find, however, that these methods are replaced by more scientific ones, derived from the art of dyeing, which, of course, reached great perfection in very early times. In the MS. of Jehan le Begue we find several recipes for the preparation of lakes in the modern method, which, as they were compiled by him from the MSS. of Alcherius, belong to the 14th century.*

We find in these recipes the substance from which the colouring matter is to be obtained is, first to be boiled in a ley, made from wood ashes or with a stale urine, and then the colour precipitated by the addition of alum. Traces of the older method, however, are to be found, as frequently the addition of gypsum as well as alum is mentioned. Some of these recipes indicate considerable knowledge of the properties of alum basic salts, and their tendency to form a precipitate under certain conditions. The following quotations from Mrs. Merrifield's translation of the manuscripts of Jehan le Begue will serve to illustrate the methods used in the 14th century:—

"*To make a rose colour.*—Take brixillium scraped very fine with a knife or with glass, and tie it in a fine piece of linen, not tight, but loose and easy. And put it, tied up in that manner, into a new glazed earthen jar, to soak in ley or in urine; and if the urine is stale, so much the better. If you cannot have any such, take very strong ley and put with the said piece of linen containing the brixillium, some of the white chalk of three or four times the weight of the brixillium, more or less, as by looking at it you may think fit, according to the goodness of the brixillium. Afterwards add some pulverized raw alum, in quantity about one-fourth of the chalk or thereabouts, more or less, and mix all the things together, always leaving the said brixillium tied up in the said piece of linen, and leave it so for about one hour. Next place the jar upon a fire, not of wood, but of charcoal, and let it boil, but not too fast for the space of a quarter of an hour or less, so as just to melt the alum. Then take the said bag of brixillium out of the vase, and press it and screw it out well, in order that the whole of the colour may run out of it in the said vase; and then remove the colour, hot as it is, from the fire, and put it on a hollow lump of chalk or upon a brick of baked clay, in order that the urine or ley may be immediately absorbed into the stone, and the colour itself remained thickened and half dry. Afterwards let it dry completely in the sun, and then remove the colour, which is of a rose colour, from the stone or brick with a knife, and put it by for use. When you wish to use it take as much as you require and powder it, that is, grind it upon a hard and smooth stone with gum water, which must be made of two-third parts of gum arabic dissolved in so small a quantity of water as barely to cover the colour when the water is added and strained through a linen cloth, and one-third part of clear water mixed with the said gum so dissolved and strained. And with the gum water, thus made, temper your rose colour to a proper consistence, and use for whatever you please."

* For instance, we find "Continentur hoc volumine de coloribus ad pingendum capitula scripta et notata a Johanne Archerio seu Alcherio, Anno Domine 1398, ut accepit a Jacobo Cona, flamingo pictore Commorante tunc Parisiis," and so on, from Jehan le Begue.

As a further example of the methods employed, the following recipe from a MS., not later than the middle of the 15th century, may be taken:—*

To make good and fine lake.—"Take 1 lb. of clippings of rosato, and put them into very strong ley made of ashes, such as the dyers use, in a new glazed jar, and set it on the fire to boil, and boil it slowly for the space of two paternosters, then pass the ley and the shavings through a clean linen strainer, and press it strongly with the hand so that all the ley may pass out; then put back the ley to boil again without the clippings, and when it is boiled, throw it on the shavings which are in the strainer, and press the strainer hard with the hand, so that all the ley may run out, and put it by. Throw away the shavings and wash the strainer well, so that there may not remain in it any of the hairs of the shavings. Next take 5 ozs. of roche alum in fine powder, and put it a little at a time into the ley, until the ley begins to settle, which you may know by its turning almost entirely to a thick scum, from top to bottom, and you must keep on mixing the ley with a clean spoon until it becomes cool, and settles; then put the ley into the clean strainer and strain it all off, and the lake will remain on the strainer. Let it remain on the strainer until quite dry, and then put it into a small basin of glazed earth full of clear and cold water, and stir and rub it up well with the hand until it diffuses itself; all the scum which rises to the top at first must be thrown away with a feather; then wash the strainer well and pour into it the water in which you have put the lake, and the clear water will pass out along with the alum, and this is called purifying it from the alum. And when the lake is nearly dry, remove it from the strainer, and spread it out with a broad knife on a new tile, let it dry in the shade, and before it has done drying, cut it into pieces according to your

* This manuscript was found by Mrs. Merrifield in the library of RR. Canonici Regolari Convent of S. Salvatore in Bologna.

fancy, and let it dry, and it is done. And know that the more it is purified from the alum, the more beautiful, and lively, and the better it is. And observe this secret, that if you wish to have the lake a brighter colour and one which will never change, when the shavings are boiling, add a lump of assafetida as large as a chestnut."

These two recipes give in some detail the general methods in use during the 15th, 16th, and 17th centuries for the preparation of lakes. There are, however, certain variations in detail that are worth noting. The introduction of assafetida is not again suggested, but in a receipt of later date the substance is boiled with fennel seed. This recipe is worth quoting in full, as it shows that they were aware that under certain conditions the colour would carry down alumina without the addition of an alkali.

"*To make a most beautiful purple lake.*—Take an ounce of fine grana or cochineal, a quarter of an ounce of roche alum, and about a bocale full of common water. Boil the water with a quarter of an ounce of fennel seed until it is diminished one-third; then add the grana or cochineal finely pulverized, and boil the whole over a slow fire for a quarter of an hour; then add the pulverized roche alum, and let it boil for another quarter of an hour. After this, take it from the fire, strain it through a linen cloth into a new and unglazed earthen porringer, and leave it there for eight days. You must then decant the water, or take it up gently with a sponge, evaporating the little which remains, until the colour is condensed, which you must afterwards keep in shells, adding to it a little lemon juice."*

I have tested this recipe, and find that a precipitate is thrown down of a purple colour. The addition of lemon juice referred to here, and in some other recipes, causes the lake to become more of a crimson and less of a purple.

Occasionally lime is to be added to the ley, prepared from wood ashes, thus making it into caustic potash; and in one recipe we are told that the urine must be kept 20 days, then boiled, skimmed, and filtered. Occasionally lime water alone is proposed instead of ley. Alum is usually called roche alum, but occasionally an alum zuccarino is mentioned. The addition of tartar is mentioned in a recipe in the Padua MS., and the addition of salisgeme, or pure rock salt, is once or twice referred to. Occasionally the addition of powdered travertine, egg shells, or fish bones is advised; and directions are frequently given for filtering the ley through the wood ashes several times with a view to obtaining a saturated solution. In a recipe given by Alcherius, a little ley is added to the alum before adding the alum solution to the coloured liquid, thus preparing a basic salt. In more than one recipe the lake is to be strained through linen, after the addition of the alum. Apparently, this would stop the pieces of dyewood or the grana from passing through while allowing the passage of the alumina. To understand this, we must remember the loose weaving of linen at that time. When the lake itself is to be filtered, a woollen bag is usually prescribed, shaped like the hood of a Capuchin friar. In some recipes we are told to dry the lake in the shade, and not in the sunlight, and occasionally the directions for filtering are omitted. The washing of the lake is hardly ever referred to.

In conclusion, we may sum up the methods used by saying that they consisted in boiling the dye-stuff with an alkaline solution, and precipitating the colouring matter with alum.

Passing from the methods of preparation, the substances usually used to prepare these lakes require next to be considered. A very large number of substances seem to have been used at different times for the preparation not only of rose colours but also of blue, green, and yellow lakes. For instance, Eastlake (p. 441, "Materials for a History of Oil Painting") mentions Graines d'Avignon weld, broom, curcuma, saffron, aloes, and the inner bark of various trees, as used for the preparation of yellow lakes. De Mayerne (1573-1655), a friend of Rubens, mentions a green lake prepared from buckthorn (Rhamnus Catharticus) and Hoogstraten says, "With us lakes are in use not only the purple, but the blue, green, brown, or tints of yellow lakes." These quotations are sufficient alone to show the large number of lakes in use at various periods in the history of art, and effectually disposes of those who imagine the old masters to have been confined to using a few colours only. Anyone who holds this view need only study the Tabula de Vocabulis Sinonimis et Equivocis colorum, at the beginning of the MSS. of Jehan le Begue, to abandon it at once. Nevertheless though so many lakes were known, those of most importance seem to have been the rose-coloured lakes. I shall therefore pass over my experiments on lakes from broom and from saffron, and consider only the substances used for the preparation of rose-coloured lakes, but I shall also include the preparation of lake from madder.

* From a MS. in the library of the University of Padua, date probably, the middle of the 17th century.

The rose-coloured lake prepared from ivy gum has already been considered. In the later recipes we find Indian lac, Brazil wood, and kermes repeatedly referred to. I shall begin by considering the lakes prepared from Indian lac.

It is sometimes doubtful whether the word lac or lacca refers to the red resin from India, or to ivy-juice, which is occasionally called lac, but it is evidently the Indian resin in the later manuscripts, and we find that it was imported for dyeing by the Catalans and Provençals as early as 1220. The colouring matter in this resin is due to the coccus lacca, which lives on the twigs of trees of the species Butea, Ficus, and Croton. These insects become imbedded in the resin which exudes from the tree, thus forming a red resinous mass, which is imported under the name of stick lac, and probably corresponds to the substance known as Indian lac in olden times. It is customary now, however, to soften the resin in water, when it is removed from the tree, by which the colouring matter is largely extracted, and the resin known as shellac separated. The solution of the colouring matter is then evaporated down into cakes known as lac dye. Until quite recently a considerable quantity of lac dye was sent into England, and I had some difficulty in obtaining a pound of it. The sample I obtained has been, I should think, overheated during evaporation and the colour partly burnt. As showing the identity of stick lac with the Indian lac of olden times, I may mention that it is stated in the Padua MS. already referred to, that on separating the colouring matter a colourless resin would be left behind, which could be used for making varnishes. I have prepared—(1) Some of the lac dye ground with gum; (2) a lake prepared by boiling the lac dye with a solution of soda, filtering and precipitating filtrate with alum; (3) a lake prepared by boiling stick lac with soda, filtering, and precipitating with alum. This lake may be considered to correspond closely to that used by the old masters.

Another substance largely used for preparing lakes is a dye-wood known as Verzino, Berxillium, Brexillium, Brasillium, and Brazil wood. It has long been known as a dye-wood, being mentioned in the book of "Roots," by Rabbi David Kimchi, and was called by the Arabs *albakim* or *bacam*. According to Marco Polo, the best quality grew in Ceylon. It was afterwards discovered in, and imported from, South America, and it has been suggested that Brazil takes its name from the fact of this wood being found there. No wood of this name is now imported from the East, but similar dye-woods, known as Sapan wood, Saunders wood, and Buc wood, are imported from the East, while the name Brazil wood is confined to that sent from South America. The different dye-woods are all varieties of Caesalpinia and probably the dye-woods now sent from the East are the old Verzino or Brexillium. I have prepared a lake from Brazil wood by boiling it with soda and then precipitating with alum. This is probably very similar to the lakes obtained from this wood by the old recipes.

As a rule, we expect to find that substances in favour with the old masters for the preparation of colours would yield permanent pigments; but this is not so in the case of Brazil wood, all these dye-woods yielding fugitive dyes.

We shall have to consider the question of the use of fugitive lakes when we come to treat of the mediums with which the pigments were ground.

The most famous of all red dyes is that obtained from kermes, a small insect of the same genus as the cochineal insect, and known as the coccus ilicis, which is found on the prickly oak or ilex round the coasts of the Mediterranean, the best quality coming from Arcadia. The female coccus is collected from the trees, and, as collected, looks like small scarlet berries, which crush to powder in the hand. The first mention of this dye occurs in the directions for the curtains of the Temple (Exodus xxvi. i.); and it seems to have been used from the earliest times for the production of a red dye. Prof. Middleton has shown me some pieces of cloth from the tombs in middle Egypt, dating from 300 A.D., which he believes to be dyed with kermes, and in which the colour is perfectly bright and fresh. It can be traced as a dye through the Middle Ages in the south of Europe. It was mentioned in a commercial agreement between Bologna and Ferrara in 1193; and Florence and Venice were famous for stuffs dyed with it in the 15th century.

The Italian name for the dye was *grana*, from which comes the English phrase "to dye in grain;" and Shakespeare has given his testimony to the permanency of the dye, when he makes Olivia say of her complexion "'Tis in grain, sir; 'twill endure wind and weather."

Hellot, in his "L'Art de Teinture" (1701), pages 244 and 264, says that the figures in the old Brussels tapestries, 200 years old, and

dyed with this substance, are perfectly fresh, and Bertholet states the dye to be quite permanent in his work on dyeing. It continued to be used till the introduction of cochineal from America in the 16th century, by which it was gradually replaced. Apparently Cortes first sent reports of the cochineal insect to Europe in 1523, and we find that Matthioli mentions it as quite common in 1549, and in the Padua MS. already referred to a recipe for lake is given, in which either grana or cochineal is advised to be used, showing that at that time cochineal had partly but not entirely replaced kermes. It is still used in Persia as a dye, but is no longer an article of commerce. The samples I have obtained are kindly given me by Mr. William Morris, who imports it for dyeing his finest reds for tapestry weaving. Lake prepared from it was known as "lacca di cimatura dé grana da rosato," and was almost always prepared from the clippings of the cloth dyed with kermes. In the recipe quoted we are directed to take these clippings, which apparently were the loose pieces of wool trimmed off the cloth before it left the dyer's hands, and could apparently be obtained by the painters in sufficient quantity from the dyers. I therefore asked Mr. Morris to dye a piece of cloth for me with kermes in order that I might test this method of preparing the lake.

The process of dyeing it was very simple. The cloth being mordanted with alum containing a little tartar, and then dyed in a water solution of the kermes, the whole of the kermes was absorbed by the cloth. I have boiled a piece of this cloth with soda, strained off the solution, and precipitated it with alum. The lake thus prepared does not differ appreciably from the lakes prepared from kermes direct.

The first recipe for the preparation of the lake directly from kermes that we find occurs in the "Arte Vetraria," by Neri (1612). This book, though mainly confined to the preparation of colours for staining glass, contains some recipes in the 7th book for the preparation of lakes, and in chapter 19 Neri states that, finding in Pisa, "non occorre Cimatura, non Maestra," he prepared kermes lake by boiling the kermes with a solution of alum, allowing it to stand for some days, and filtering. I find that if kermes is boiled with alum in this way, and allowed to stand, the precipitate of a rose-coloured lake is gradually formed. Some recipes also occur in the Padua MS. for the preparation of a lake direct from kermes. I have made a lake prepared by boiling kermes with soda, filtering, and precipitating with alum.

As already stated, few references to lakes prepared from madder occur. It was largely used for dyeing, and was therefore probably used for the preparation of lakes. Besides the reference to it in the MS. of S. Audemar, Theophilus refers to a substance called "menesch," which seems to be a corruption of the Indian name of the root *mnitsch*, and Neri gives a madder lake recipe in the "Arte Vetraria," book 7, chapter 118.

It is hardly necessary to collect examples for its use as a dye, but, in passing, we may mention that some of the cloth from the Egyptian tombs, already referred to, is evidently dyed with madder, the colour being perfectly preserved. That it is mentioned in the statutes of Marseilles (1287), that its cultivation was much encouraged by the Emperor, Charles V., in Holland, and that the curious regulations as to its use by the greater dyers only, show in how much esteem it was held.

In my experiments on madder lakes, I have made use of the preparation known as alizarine.

In conclusion, I would like to point out that, with the exception of madder, the lakes described are all very similar in tone of colour. I have described them as rose-coloured lakes, translating by this word the words roseli, roxita, roxeum, roxaceum, roseo, rosa, and so on. A recipe given in the Padua MS. helps us to settle what was meant by the description rose-coloured, and to confirm my belief that the lakes I have made closely resemble those made during the best period of art. The recipe is as follows:—

"*To make Brazil wood of four colours.*—Take Brazil wood, and steep any quantity you please (so that it is more than a third part) in clear water, until the colour is very red (rosso). Then divide this colour into four parts. If you wish to make a rose colour (rosato), use it pure; if you wish it purple (pavonazzo), use lime water, but the water must be tepid; if you wish a violet colour (violato), add a ley to it; and if you desire that it should be of a mulberry colour (morello), add tartar."

I have stained (1) a piece of paper with Brazil wood water, and therefore the rosato colour, which is a purplish red; (2) a piece of paper stained with Brazil wood water, rendered alkaline with soda, and therefore of the violato colour.

Even if we include madder amongst the lakes they used, they had evidently nothing which corresponded in tint to the cochineal

lakes, or so-called madder lakes used by modern artists. This, doubtless, accounts for the fact which I have been told by experts, that modern lakes cannot be used in copying the old masters.

It may be asked how the magnificent reds were produced by means of these lakes. The following quotation from the Padua MS. throws some light upon this :—

"7. The mixtures of cinnabar. The colour of ripe strawberries is imitated with cinnabar and lake. Scarlet is made (scarlato) with cinnabar, lake, and white lead. Blood colour is made with cinnabar and lake. The red colour on the cheeks of beautiful flesh is represented with cinnabar, lake, and white lead."

I have tried some experiments on this point, and find that very rich crimsons can be obtained by glazing one of these rather dull purple-coloured lakes over vermilion, and many of the rich robes in the pictures at the National Gallery can be matched in this way very well, though usually somewhat browner in tone. An interesting example of a figure just ready for such glazing is the St. John in the "Entombment of Christ" (790), apparently painted in red lead.

Examples of the purple lakes themselves can also be found in many pictures, and in various states of preservation; some very bright (see angel's robe in the Botticelli, 275), some very much faded (see the Roger Van der Weyden, 664).

The combined red produced by glazing the lake over vermilion is less likely to alter seriously with time, because the dulling of the lake is compensated for by the fading of the lake, and therefore the shining through of the vermilion. I have found, for instance, that even Brazil-wood lake, used in this way, produced a fairly durable red.

With reference to the permanence or otherwise of the lakes described above, Brazil wood fades in a few weeks, or on exposure in a south window; lac lake is half gone in a couple of months; kermes is considerably faded in twelve months, while, under the same tests, madders are unchanged. None, therefore, of these old lakes, can be recommended for re-introduction; but if a lake is required for glazing vermilion, some shades of purple madders are probably better than even kermes.

The blacks mentioned by Cennino are three in number, black chalk, a chalk prepared by charring the young shoots of the vine; a black from almond skins or peach stones; and lamp black.

Ivory black was also known, though not mentioned by him. With reference to lamp black, Vasari says that it has a tendency to darken in time, and gives this as the cause of Raphael's "Transfiguration" in the Vatican. (Page 57, vol. iii., Bohn's translation.)

It will be noticed that he mentions no browns. Brown, however, such as umber and asphaltum, were known and used. The use of asphaltum is an interesting example of how a little care can make all the difference. Many modern pictures have been spoiled by it, and artists are afraid of it. In the old recipes, however, we are directed to roast it before grinding in oil. Prof. Church, in his recent book on pigments, gives his testimony that this is perfectly successful, and the pigment may then be ground in oil and used with impunity.

Besides these colours, Cennino mentions indigo, and states that a fine green can be made by mixing it with orpiment. He probably, however, only means it to be used in miniature painting.

Having thus gone through the list of pigments given by him, it is of some interest to collect those that he regarded as safe for use in fresco. These were sinopia, amatisto, yellow ochre, Naples yellow, verde terra, bianco sangiovanni, and black. No blue is mentioned, though elsewhere he talks of using indigo, which is difficult to understand. Of these colours one is wanting from the modern palette, namely, Naples yellow. How far as safe a palette can be selected from among modern pigments I do not know. I think, however, that if blue copper frits are introduced again, or cobalt, blue used, with cobalt green and oxide of chromium green, that a fairly safe palette could be made up along with the earths given above. I have already described and shown how the purple lakes can be effectively used by glazing over vermilion, how verdigris looks over yellow ochre, and how gold can be used as a pigment.

In conclusion, beyond perhaps the Egyptian blue, I do not know of any colour which we really require to introduce from these old palettes. Many of their finest pigments either will not permanently stand modern city air, or cannot be trusted in the hands of a modern artist. In the next lecture we have to deal more fully with the method used to protect certain pigments, but enough has been said already to show that care had to be and was taken to guard against the weakness of each pigment used. This cannot be done under modern conditions, and, consequently, while

gaining many hints and much that is suggestive and useful from their study, I do not think that we have to seriously attempt to re-introduce many of them into the modern palette. What is required to make the modern palette safe is exclusion, not inclusion. It is true that many pigments were known to the old masters, many more than I have described in these lectures, yet I do not doubt that the best painters rigidly excluded most of them, and carefully selected those thoroughly proved. When they had to use lake, verdigris, or orpiment, they took especial precautions to insure its durability. It will be noticed that out of the pigments known to him, Cennino Cennini only selects seven as suitable for fresco painting.

In the next lecture we shall treat of the medium with which these pigments were mixed.

Miscellaneous.

JOURNAL OF INDIAN ART.

In the numbers of the *Journal of Indian Art* for October last, and January, 1892, Mr. William Griggs published a continuous series of illustrations of the collections of Indian art belonging to his Royal Highness the Prince of Wales, and shown at Marlborough-house and Sandringham-hall. The examples illustrated have been selected either for their artistic merit, technical skill, or sumptuary splendour; and everyone of them is a masterpiece of Indian decorative work. Mr. W. Griggs has reproduced these works in photo-chromo lithography with great success. The plate of an Ahmedabad kincob is said to be the very finest mechanical facsimile of a textile fabric that has ever been executed.

Beside these illustrations, there are others of Marlborough-house, and Sandringham, and portraits of the Prince and Princess of Wales, and a graphic table of the pedigrees of their Royal Highnesses, compiled from Mr. Burdett's work entitled "The Prince, Princess, and People."

The descriptive text is by Sir George Birdwood, and the following three extracts are taken from this.

AN "ARGHA"-SHAPED "ATAR-DAN" OF JEYPORE ENAMEL.

The round dish in Jeypore enamel [No. 66] is the largest of its kind ever produced, and took four years in making. Like all other examples of this work, it is glorious in colouring. The next object [No. 67] is interesting, from its resemblance to the "Ciborium minus,"* or pyx, in which the "Host" is kept after consecration, as "the Blessed Sacrament;" and there can be little doubt of the Mediæval Christian church having borrowed both the design and purpose of this vessel from the lotus-form *argha* or *yoni* used in the religious services of the Hindus. Ordinarily, the *argha* is shaped like a beast [*argha-patra*, cf. Argo, and "patera"], after the manner of the *cymbium* of Isis, and used emblematically as a cornucopia [horn of Amalthea], in pouring libations of milk, honey, &c., and in making offerings of grain, fruits, flowers, perfumes, &c., to the gods and the Brahmans, and to bridegrooms and other worshipful persons. But when shaped as an 8, 12, or 16-petalled lotus, folded on an inner cup, just as the flowers of the *Nelumbium speciosum* are folded on their honeycombed seed-bearing "torus," it is meant to hold and enshrine the lapilliform *lingam* [to be distinguished from the *salagrama* of Vishnu] sacred to Siva, the "Lord of the *argha*" [Argha-natha], as Mahadeva, "the Great God" over all gods. The *argha* itself always symbolises *Parvati*, "the Mountaineer," the consort of Siva. In the "Tree of Life," with its affronted guardian beasts [cherubim], we have the ultimate poetical and artistic rendering of crude ideas suggested primarily by the same physiological phenomena; and the familiar "cone pattern" on Indian shawls, kincobs, chintzes, and carpets, of which so many absurd explanatians have been attempted, is but either a phalliform lotus bud, or, as in its ultimate evolution, the "Tree of Life" growing within "the Garden of Eden," the latter still being represented archaistically, as in the so-called "vesica piscis" of Christian art.

A "KINCOB."

The last illustration [No. 77] is of an Ahmedabad kincob [Persian *kinkhwab*, Mediæval "cammoca," French *mocade*, and English "mockado," this last form of the word having been used for a mock velvet!] or brocaded "cloth of gold" † [cf: Chinese *kim*, or *kin*, "gold."] Each end of it represents a "Paradise" [Persian *firdaus*, cf: Firdausi, "the Paradisaical," from the Sanscrit *para-desa*, literally "a far-country"] set with four pots [cf: the "Venus-Gardens" of the Greeks and Romans] of the celestial [*i.e.* planetary] "Tree of Life," enclosed within its "cone" shaped "mystical almond" ["vesica"], here derived directly from the sacred lotus-bud; the whole woven in silks of the gayest colours on a stiff ground of radiant gold. The four square "Paradise"

* See also "The Kennett Ciborium," by Mr. Archibald Constable, in *The Scottish National Memorials*, Glasgow, James MacLehose and Sons, 1890. This admirable monograph has since been reprinted, with additions by Mr. Constable.

† At first these brocades or broches, *i.e.*, "embossed" stuffs, were wholly of gold, but gradually silk was introduced in their manufacture, either as a ground for the raised charging of gold, or for the variegated patterning on a ground of intercurrent gold.

is bounded by a border of lotus flowers blooming on an angularly undulating stalk, along each side of which passes an unending procession of parakeets, inwrought of red and green with the most archaic conventionality, but every one alive, and rejoicing aloud in the unclouded sunshine of their life. There is no mistaking their voice of joy, which is the distinctive note of all the best Indian art. The body of the kincob is of tawny crimson, striped with bright gold, and diapered between the bright gold stripes with alternate lotus buds and flowers ["knop and flower pattern"] of dulled gold. It is worn as a robe by the women; and beholding a high-caste Hindu lady of the Mahratta country in such glorious apparel as this, floating about her in waves of gold like a lambent aureole, Homer's familiar line of Helen is instinctively recalled to one's lips:—

> "What winning grace! and what majestic mien!
> She moves a goddess, and she looks a queen!"*

On the Use and Abuse of Tradition in Decorative Art.

I have selected these illustrations, not to tempt our English manufacturers to copy them, but to enkindle their admiration, wonder, and imagination to nobler achievements in their own industrial arts. But in protesting against our designers slavishly plagiarising Indian patterns, I do not mean that they should not receive suggestions from them as to the general forms and disposition of the ornamentation of English manufactures. The general forms belong to all the world. They have probably originated spontaneously everywhere among the artistic races of the world; and it is not possible for man, with his limited powers of invention, to get away from them, nor, indeed, is it in the least degree desirable; for one of the greatest charms of human life is the essential unity which underlies the infinite variety of its manifestations, whether in nature or art. But what our designers should do is to give just this variety, derived from local conditions and circumstances, to the few really decorative types they have inherited, in common with all the rest of the world, from the dateless past. The details, therefore, should all be of pure English origin. We rarely find the lotus flower and bud in modern Persian art, but we always find the same knop and flower pattern, which was represented in ancient Persian art, either by the lotus flower and bud, or by the leafy head of the date tree and its cluster of fruit, these forms being replaced in modern Persian art by the rose, tulip, pink, narcissus, and other native flowers of the country. The knop and flower pattern, as represented by the lotus and its bud, probably originated in Egypt, and thence passed to Assyria, and it is from the latter country that the permutations of it seen on the Buddhistic sculptures of Bharhut, Sanchi, and Amaravati were obviously derived. From Assyria and Egypt it passed into Greece and Italy, and over all modern Europe. We have, therefore, not only a right to the use of the knop and flower pattern because in its crude shape it suggests itself, like the cross and key patterns, naturally to every one, as may be seen in the first efforts of clever children in designing, but because we have inherited it historically. But what we have to do for ourselves is to quicken the decorative forms we have received from other countries, with our own national, civic, and family, and, I would add, personal life; by adapting to them our own country fruits and flowers, and animals, and our own religious and state symbols, and civic and family arms and crests, and the emblems of our own personal lives. In this way every family in England might, as is the case with the handicraft families of the East, have its own designs in carpets, curtains, wall papers, lining papers for books, and in glass and crockery, as well as in family plate. The complete nationalisation of English art in this way, under the direction of the first masters of the age, would probably, in a generation, transform us into a finished artistic race, and give our manufactures a legitimate hold on the markets of the world we might then hope to never lose again. The knop and flower pattern is conspicuously represented on the Bharhut and Sanchi sculptures by a full-faced lotus flower, alternating with lotus buds, placed end to end, so as to fill up the space between the flowers with an hour-glass-like ornament. We find this arrangement of the knop and flower pattern constantly repeated with more or less of local character, in Greek, and Roman, and modern European art. It occurs in the vestibule of Drury-lane Theatre, where its representation is almost identical with that found at Bharhut and Sanchi. It is seen on thousands of London houses, and often on London garden-walls, in which the "flower" is represented by a course of round holes in the wall, the parapet of which is supported by the hour-glass-like "knop" done in solid masonry. It is always interesting to observe these more or less literal representations of the same ancient forms. They please a learned man, and they may satisfy a cultivated man's sense of academical propriety; but they never touch the heart of any man, simple or cunning. When, however, Messrs. Wedgwood and Co. exhibited at Paris, in 1867, an earthenware dessert service, in which all the plates and dishes were ornamented with the red-tipped daisy flower and daisy bud, in the same knop and flower arrangement, every one who saw it was delighted. Nothing could be more fresh, attractive, and satisfactory in every way. The design pleased all the more because while it was of the simplest and the happiest originality, its direct historical descent from the art of Nineveh, Athens, and Rome was obvious. There is always a fascination in thus preserving our historical connection with the past; and its severance involves no less a loss in art than in social economy and politics.

* Literally:—"How awfully like she is to the immortal goddesses."

ROADS AND HIGHWAYS IN CHINA.

The United States Minister at Peking, in a recent report to his Government, says that road-making is an art which among the Chinese has never been brought to any great perfection. The explanation, probably, is that in the greater part of China proper there are waterways, natural and artificial, crossing the plains, while human labour has always been found preferable to pack-horses or other beasts of burden over narrow and circuitous mountain passes. In Southern China, at the centres of the tea trade, the long string of coolies bearing down from the hills the leaves, in deep baskets slung on poles, is a familiar sight. The transport of brick tea over the mountain roads of Syn-chuan into Thibet, a trade said to amount to £200,000 annually, is also effected by coolies, who here, on account of the steepness of the defiles, do not use carrying poles, but bear the tea on a wooden frame strapped to their shoulders. In this way they make a fifteen days' journey over mountain paths, bearing about 100 lbs. of tea each, for which service they receive about 14s. or 15s. The importance of military roads appears never to have been impressed upon the Chinese. In Northern China, where waterways are not so numerous as in the south, intercommunication has always presented serious difficulties, which no attempt has been made to overcome. Bridges have been built over some smaller streams, but are not kept in repair. The large rivers are to be crossed by ferries only, the smaller to be forded. In some places there are bridges, which are too narrow to be crossed by carts, where the mules are taken out and led singly, while the carts are carried over on men's shoulders. In times of flood there is frequently no way of crossing at all. The roads themselves, outside the cities, are merely a line of ruts across the fields. In winter, when free from rain, as they are for nine months in the year, they keep in very good condition. In summer, they are an impassable bog; and transit, except on foot, is suspended. Inside the cities some of the crowded thoroughfares are paved with massive blocks of stone. The importance of the rapid conveyance of intelligence to the centre of Government from the outside provinces has always been felt. In the days preceding the introduction of the telegraph this was accomplished by an elaborate system of post stations. These were placed some 30 miles apart, and relays of horses constantly kept in readiness for the Imperial courier. By these means despatches have been sent to distant prominent capitals at the rate of 250 miles a day. The following custom prevails with reference to the official courier service in Thibet:—The express courier from Gartok to Lhara, a distance of 800 miles, travels night and day. He is not relieved *en route*. His clothes are, says the United States minister, sealed on him, and can only be removed after the seal has been broken by the proper official. These messengers are lifted at the post station from one horse to another, and sometimes die on the way from exposure and fatigue. It is remarkable that the various systems of government and private posts should exist without leading to the construction of proper post roads and highways in China. Over some mountain roads, however, which would otherwise be impassable, considerable work has been done and money expended. In some places the paths over the passes have been simply paved for foot passengers, but in others provision has been made for the passage of carts. Most of these roads date from very remote periods, but there are occasional instances of recent construction and repair. The most important of recent improvements is the putting in order of the road through the Chü Yung Kuan, north of Peking. This is the pass leading into Mongolia from China, through the Great Wall, past the cities of Nankou and Kalgan. It is familiar to all travellers to Peking as the Nankou Pass. The work of repair here was undertaken by the Viceroy Li Kung-chang some years ago, and the road itself is said to be of the most creditable character. Drains have been made, substantial bridges built, inequalities levelled, and obstructing rocks hewn away. This new road, says the American Minister, will be of great benefit to local traffic, but particularly for the transport of the immense quantities of tea sent by Russian merchants, on camels, from Tungchou to Kiachta, *viâ* this pass.

Obituary.

Sir George Airy, K.C.B.—Sir George Biddell Airy, K.C.B., F.R.S., who died at Greenwich on Saturday, 2nd inst., in the ninety-first year of his age, was awarded the Albert Medal in 1876, "for eminent services rendered to commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships." Mr. Airy entered Trinity College, Cambridge, in 1819, and was Senior Wrangler in 1823. During his tenure of the Plumian Professorship of Astronomy, to which he was elected in 1828, he acted as director of the Cambridge Observatory. He held the office of Astronomer-Royal from 1835 to 1881, and that of President of the Royal Society from 1871 to 1872. It is not necessary to register here the particulars of the late Astronomer-Royal's active and distinguished career, but it may be mentioned that on several occasions he attended the meetings of the Society and joined in the discussions. On February 11th, 1855, he presided at a meeting, when the question of the expediency of the decimalisation of British money and weights and measures were discussed.

General Notes.

CHICAGO EXHIBITION.—A communication on the participation of the Republic of Ecuador in the Chicago Exhibition, from Mr. Alfred St. John, H.B.M.'s Minister at Quito, addressed to the Marquis of Salisbury, has been forwarded from the Foreign-office to the Secretary of the Royal Commission. It is expected that the Republic of Ecuador will make a very varied and interesting exhibit. It has been allotted 3,000 feet of space, and the building to be erected will be upon the model of her building at Paris in 1889, in representation of an Inca Temple. As many of the Equatorian Exhibits at the Paris Exhibition of 1889 as can be secured will be sent to Chicago. Most of the exhibits at the National Exhibition to be held at Quito in 1892 will be sent to Madrid in 1892, and thence to Chicago in 1893.

PARIS EXHIBITION.—The *Economiste Français* publishes a detailed analysis of the receipts and expenditure connected with the Universal Exhibition of 1889, the net financial outcome of the Exhibition being a balance of about £400,000 to the good. The receipts were made up of the money paid for admission, the produce of different concessions and lettings of space, the sale of materials afterwards, the subsidy of the city of Paris, and the amount contributed by the State. There were no fewer than 125 concessions of various kinds for cafés and restaurants, which produced about £90,000, while a sum of nearly £9,000 was received for concerts, subscriptions to water and gas, the total receipts amounting to £2,000,000, or £280,000 more than the estimate for them. The receipts of the 1867 Exhibition were £1,050,000, while those for the Exhibition of 1878 did not amount to more than £927,000, including a subsidy of £248,000 from the city of Paris. Upon the other hand, the expenses of the 1889 Exhibition, which had been estimated at £1,860,000, did not amount to more than £1,600,000, while for the 1867 Exhibition they were £936,800, and for that of 1878, £2,216,000, including a sum of £560,000 spent upon the Palace of the Trocadéro. In other words, while the 1889 Exhibition left a profit of £400,000, that of 1867 gave one of only £112,000, and that of 1878, organised at the cost of the State, left a deficit of £1,268,000. It should be pointed out, however, that in 1878 there was no subsidy from the State, whereas in 1889 the State contributed £680,000, and in 1867 £240,000. —*The Times*.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 20.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention." Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

JANUARY 27.—F. W. EDRIDGE-GREEN, M.D., "The Scientific Value of Lovibond's Tintometer." R. BRUDENELL CARTER, F.R.C.S., will preside.

FEBRUARY 3.—T. PRIDGIN TEALE, "Dust, and How to Shut it Out." Dr. T. E. THORPE, F.R.S. will preside.

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

Papers, the dates of reading of which are not yet fixed:—

"The Pamirs." By Capt. F. E. YOUNGHUSBAND.

"Iceland." By TEMPEST ANDERSON, M.D.

"Ancient and Modern Art Pottery of Japan." By ERNEST HART.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

JANUARY 12.—ERNEST SATOW, C.M.G., "The Laos States of Upper Siam." 4.30 p.m.

FEBRUARY 16.—LEWIS ATKINSON, "The Kimberley Exhibition."

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru."

Papers, the dates of reading of which are not yet fixed:—

"Australasia." By Sir EDWARD BRADDON, K.C.M.G.

"Newfoundland." By Sir WILLIAM WHITEWAY, K.C.M.G.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

JANUARY 21.—HERBERT JONES, "From Tien-Shan to the Pamirs—experiences on the Russo-Chinese Frontier." The paper will be illustrated by lantern slides.

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-General Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19.—JERVOISE ATHELSTANE BAINES, C.S.I., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 26.—WILLIAM MORRIS, M.A., "The Woodcuts of Gothic Books." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., will preside. The paper will be illustrated by lantern slides.

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets."

MARCH 8.—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE T. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock :—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.
January 25, February 1, 8, 15.

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.
February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.
March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bateriolology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."
February 5, 12, 19, 26, March 4, 11.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 11 ... London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Silvanus Thompson, "Complimentary and Supplementary Colours."
Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, JAN. 12.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Foreign and Colonial Section.) Mr. Ernest Satow, "The Laos States of Upper Siam."
Medical and Chirurgical, 20, Hanover-square. W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Wilfrid Airy, "Weighing Machines."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m. Mrs. French-Sheldon, "Customs among the Natives of East Africa from Teita to Kilimegalia, with special reference to their Women and Children."
Biblical Archæology, 9, Conduit-street, W., 8 p.m. Annual Meeting.
Colonial Institute, Whitehall Rooms, Northumberland-avenue, W.C., 8 p.m. Profcssor Anderson Stuart, "University Education in Australia."

WEDNESDAY, JAN. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Juvenile Lecture. Prof. J. M. Thomson, "The Three States of Matter—Solid, Liquid, and Gaseous." (Lecture II.)
Manchester Geographical Society, 44, Brown-street, Manchester, Prof. T. H. Core, "Meteorology in Relation to Geography."
Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. H. E. Davis, "Glass among the Ancients."
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, JAN. 14...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Mr. C. T. Knaus, "Some Aspects of the Reign of Terror."
Imperial Institute, University College, Gower-street, W.C., 5 p.m. Major-Gen. Sir Frederick Goldsmid, "Persia: its Language and Literature."
Electrical Engineers, 25, Great George-street, S.W., 8 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 15...United Service Institution, Whitehall-yard, 3 p.m. Mr. E. A. Cazalet, "The Russian Language and Literature." Part II.
Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. J. Roxburgh Sharman, "Testing and Inspecting for Commercial Purposes."
Junior Engineering Association, Westminster-palace-hotel, S.W., 8 p.m. Mr. G. V. C. Holmes, "Modern Applications of Electricity to Metallurgy."
Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m.

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FRIDAY, JANUARY 15, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 13th inst., Professor J. M. THOMSON delivered the second of his course of Juvenile Lectures on the "Three States of Matter," in which the relation of the solid, liquid, and gaseous states to each other, and the different changes which may be observed in the action of various material substances on each other when in the different states, were fully dealt with. Professor Thomson divided his subject into the changes produced between solids and solids, solids and liquids, solids and gases, liquids and liquids, liquids and gases, gases and gases. In the first section he spoke of the mechanical adhesion of solids, passing to the physical and chemical changes which may be produced between solid substances.

Professor Thomson then demonstrated the phenomena of solution and crystallisation of solids from liquids, pointing out the variety of solvents and their action on various substances. In connection with solids and gases, he showed the phenomena of the absorption and of the occlusion of gases by solids, the last being illustrated by the occlusion of hydrogen by palladium. He demonstrated the chemical action produced between solids and certain gases.

In demonstrating the changes produced by liquids on liquids, Professor Thomson showed the phenomena of contraction, and of the production of heat on the mixing of certain liquids, and then pointed out the questions dealing with the absorption of gases by liquids, and the circumstances of temperature and pressure regulating such absorptions. The lecturer concluded by showing the various changes which are produced between gases, passing from the formation of mere mixtures of gases to the formation of new forms of gaseous matter, and finally to the formation of liquid and solid bodies by the combination of gaseous matter.

The lecture was fully illustrated by experiments.

On the motion of the CHAIRMAN (Mr. Francis Cobb), the cordial thanks of the meeting were voted to Professor Thomson for his interesting and beautifully illustrated lectures.

Professor THOMSON, in acknowledging the vote, referred to the assistance he had received from Mr. Jackson, demonstrator of chemistry at King's College, in the preparation and exhibition of the experiments.

Chicago Exhibition, 1893.

CEYLON COMMISSIONER.

The Secretary of the Royal Commission has received from the Secretary of State for the Colonies information that Mr. J. J. Grinlinton, an unofficial member of the Ceylon Legislative Council, has been appointed by the Governor Special Commissioner for the Colony.

LIVERPOOL CHAMBER OF COMMERCE.

The Liverpool Chamber of Commerce have reconsidered the decision they arrived at last month, not to act as a local committee for the Chicago Exhibition, and the Secretary has informed the Secretary of the Royal Commission, that the Chamber having rescinded their previous resolution, are now prepared to serve as a local committee for Liverpool, and to distribute information about the Exhibition in their district.

TRANSPORTATION DEPARTMENT.

The authorities of the World's Columbian Exposition have issued a pamphlet on the classification of the Department of Transportation exhibits—railways, vessels, vehicles, &c.—from which the following information is extracted:—

For the first time in the history of world's fairs, has been decided to give the science of transportation, in its broadest meaning, that attention to which its importance entitles it. The development of modern transportation has been so recent and so rapid that its significance has hardly been understood. Already its early history is, in many instances, fading away or utterly lost. Judged by their relations to the every-

day life of the world, no other industry surpasses it in utility, or equals it as a power in the progress of civilisation. Considered from the standpoint of the amount of capital invested, it overshadows every other industry. Prof. Arthur T. Hadley, of Yale College, says:—"The railroads of the world are to-day worth from 25,000 to 30,000 millions of dollars. This probably represents one-tenth of the total wealth of civilised nations, and one-quarter, if not one third, of their invested capital. It is doubtful whether the aggregate plant used in all manufacturing industries can equal it in value. The capital engaged in banking is a trifle beside it. The world's whole stock of money of every kind—gold, silver and paper—would purchase only a third of its railroads." If to the railroads we add the shipping of the world and all means of conveyance on common roads, the magnitude of the interests represented in this department of the World's Columbian Exposition may be fairly estimated.

Plan and Scope.—It is the intent of this department that it shall fully and fairly present the origin, growth, and development of the various methods of transportation used in all ages and in all parts of the world. As far as possible, the means and appliances of barbarous and semi-civilised tribes will be shown by specimen vehicles, trappings, and craft. Past history will be illustrated by relics of the earlier days. It is hoped that in the interest of historical accuracy and the preservation of important relics which are now daily passing away, the attention of the Department of Transportation Exhibits may be called, by its friends in all parts of the world, to exhibits of this kind which may and ought to be secured. The development of water craft from the crudest forms to the modern ocean steamship; of wheeled vehicles, from the first inception of the idea of the wheel to the present seeming perfection; and of that greatest of all means of transportation—the railway—will also be further illustrated by accurate models, drawings, plans, and designs in cases where the actual apparatus, appliance, or machine itself cannot be exhibited. It is the desire of this department to keep the historical feature clearly in view, and even to magnify it. By so doing, the greatest exhibition of the actual means of transportation employed throughout the world to-day will stand out in high relief by contrast; and the wonderful achievements of recent years will bear more weighty testimony to the genius of the age in which we live. The classification is intended to be reasonably full and complete, but not to enumerate by name all possible or probable kinds of exhibits. A careful perusal of it will prove suggestive and helpful to intending exhibitors. It may seem to include some things which it is difficult to show in an exhibition of this kind, but the object kept in view is to make so complete an exposition of the methods and means employed in every branch of the business of transportation, that the earnest student of the science may here find everything at his hand, without encountering the difficulties which now beset and environ such study and investigation. A grand object-lesson will be presented so clearly and impressively that a child may learn in hours and days what would otherwise require months and years. But in addition to the object-lesson, there will be a gathering of plans, designs, blanks, reports, monographs, literature, and everything appertaining in any way to "methods of abridging distance," such as has never been made before, and such as must have an appreciable effect upon future growth and development. The tendency of such collections, and the inevitable comparisons resulting, is to bring the lowest up to the level of the best, and to stimulate to an extraordinary degree both the adoption of the most improved methods, and the invention of new means.

The Building.—The building for the display of transportation exhibits is eligibly located on the western bank of the large lagoon surrounding the beautiful wooded island, which occupies nearly the centre of the Exposition. It is near the main entrance to the grounds, and convenient of access for those arriving by all routes. The building is surmounted by a cupola reaching a height of 165 feet. Eight elevators will run from the centre of the main floor to balconies surrounding the cupola at heights of 115 and 128 feet. The view from this observatory will be beautiful in the extreme, and will give visitors an excellent comprehension of the whole plan of the Exposition grounds at a glance. The architects of the building are Messrs. Adler and Sullivan, of Chicago, who are well known as the architects of the Auditorium and other great buildings. Its general architectural treatment is simple, but with exceedingly rich and elegant details. The main entrance will consist of an immense arch, decorated with carvings, bas-reliefs, and mural paintings. It will be treated entirely in gold leaf, and will be known as "the golden door." Numerous minor entrances are provided, as shown in the plans, and with them are grouped terraces, seats, drinking fountains, and statues. The interior of the building is treated much after the manner of a Roman basilica, with broad nave and aisles. The roof is in three divisions; the middle one rising much higher than the others, and its walls pierced to form a most beautiful arcaded clerestory. The main building covers a space of 960 feet in length, by 256 feet deep—but as shown in the plans, the main floor includes nearly nine acres of additional space under roof. The total floor space, including the *entre sol*, is nearly seventeen acres. A 75 feet transfer table will travel the annex, along the western line of the main building. Railway tracks will be laid in the annex at right angles to the transfer table. The heaviest locomotives and cars can be run direct from the installaton track, which runs alongside the southern end of the building, upon the transfer table which will take them to their proper tracks inside the building. The length of these tracks is such that an entire train can be

shown connected as when in actual use. When installation of heavy exhibits has been completed, the pit of the transfer table will be floored over. The annexe will open into the main building in such a manner as to afford long and striking vistas down the main avenues and aisles.

The Railway Exhibit.—A space of over eight acres is devoted to this interest. The plan adopted provides for the best possible utilisation of space. Exhibitors will have every opportunity for showing their appliances and devices to the best advantage. As far as possible, arrangements should be made by joint agreement for showing everything in its proper place and relations. Locomotive appliances can best be shown on locomotives, and the appurtenances and furnishings of cars, on cars. Specimens of standard permanent way will afford opportunity for showing track materials, tools, and all that appertains thereto in the best possible manner. It is believed that nearly all of the establishments engaged in locomotive, car, and bridge building, will be represented. A large number of the leading railways of the world will also make exhibits of their standard roadbed, track, and equipment. The opportunity thus offered for joint action is almost unlimited, and by proper placarding where necessary, every exhibit may be given proper prominence. European railway appliances and machinery have never been exhibited on any large scale alongside those used in America. It is hoped that the undoubted influence of this Exposition upon railway development in the future great markets of the world for railway material will be sufficiently appreciated to bring out the desired comparison on a large scale. Abundant and choice space has been designated and reserved for foreign countries; and every possible facility will be afforded foreign exhibitors.

Intramural Transit.—Street railways—surface, underground, and elevated—are to be shown very completely in this department. Everything relating to their permanent way and equipment is here included, with the single exception that electric motors must be shown in the Department of Electricity. Cars and other supplies for electric roads belong in this department—a division which, while seeming to be arbitrary, is evidently necessary.

Carriages and Other Vehicles for Common Roads.—A large portion of the floor space of the transportation building proper will be devoted to this display. Included in it, it is hoped to show, with heretofore unequalled completeness, all of the characteristic forms and types of wheeled vehicles, except those used on railways. The classification is to be closely maintained, and exhibits of this nature from all countries are to be shown together, so that the most interesting and instructive comparisons may be made. Harness, saddlery, and horse trappings of all kinds are here provided for. Other vehicles and conveyances, such as those used on snow, and those employing human muscle as the motive power, are also included in this classification.

Bicycles.—This most recent of all road vehicles will receive the attention to which its unequalled popularity and rapidly increasing use entitles it. No maker of "cycles" of any importance in the world can afford to miss the greatest opportunity ever offered to place his wares advantageously before millions of possible purchasers.

Aerial, Pneumatic, &c.—Transportation through the air and by means of air is yet in a comparatively undeveloped condition. Whatever is worthy in past achievements may here appear, and whatever there is of present success or future promise. Whether or not this realm is ever conquered by human ingenuity, the subject will always be a fascinating one.

Marine Transportation.—Every known method o transportation on water may be shown in this division. Small craft of all kinds may be exhibited in full size; vessels, from the nature of the case, must be shown by models. For fuller illustration, drawings, plans, and paintings will be shown. Principal attention will be given to the merchant marine. The navigation of the inland waters of the world, especially the great lakes and rivers, will doubtless be illustrated more fully than in any previous Exposition. The classification provides, also, for everything of interest connected in any way with the subject of navigation. The government of the United States will make its naval display in connection with its own building. Foreign governments, builders of vessels of war and defence, throughout the world, and manufacturers of naval supplies, are invited to exhibit in this department, and are assured of every consideration. The separate exhibit of the United States Government will not prevent a representation of its naval history and its present plans by means of models, &c., in this department.

Proceedings of the Society.

CANTOR LECTURES.

PIGMENTS AND VEHICLES OF THE OLD MASTERS.

By A. P. Laurie, M.A.
King's College, Cambridge.

Lecture III.—Delivered December 14th, 1891.

MEDIUMS.

The use of mediums can be divided into two groups, those used before and those used after the introduction of oil painting. It is a mistake, however, to suppose that oil and its properties were not known before the introduction of oil painting. Oil varnishes seem to have been known to the ancients, and are described by Theophilus. Cennini himself, a tempera

painter, describes the preparation of a drying oil and its use for painting. As we have already seen, he describes an oil varnish as a mordant for gilding, and he also states that pictures, after being painted, must be varnished.

Apparently the custom of the tempera painters was to paint with a medium of white of eggs, or yolk of eggs, or size (the paint size being made from parchment), and then varnish the finished picture.

There is one point, however, which seems to have been very generally overlooked in this connection, though it is certainly mentioned by Eastlake. It was a common practice to add the juice of the fig-tree to the white of egg. Now the fig-tree belongs to the same family as the India-rubber tree, and its juice contains caoutchouc. We are thus brought to recognise the interesting fact that caoutchouc was used as a medium for painting long before its properties were known. Doubtless the mixture of albumen and caoutchouc would make a very tough and protective medium.

Van Eyck is generally recognised as having introduced painting in oils, though he cannot have been said to have invented oil painting. Doubtless he made many little improvements which brought oil painting into general use.

The grinding of colours seems to have been done from very early times in the same way with the muller. The method is still used for small quantities of colour. It is interesting to note, however, that the Egyptians do not seem to have known of the muller. They seem to have rubbed lumps of the colour itself round the sides of a round stone basin moistened with water. The best mullers are made of porphyry.

The preparation of the linseed or walnut oil (the two oils used by the old masters) will shortly be dealt with. Besides these oils, the materials for making varnishes were juniper resin, sandarac, amber, the balsam of the silver pine, or oleo de abezzo, the balsam of the larch; and, later, mastic and other Eastern gums. I shall not trouble you with all the learned discussions as to the nature of the varnishes used. Recipes exist in plenty, and show that in the earlier varnishes these substances are dissolved in oil. Later on, in the 16th century, spirit varnishes were introduced—that is, the resins were dissolved in turpentine or natural naphtha. The main distinction between modern varnishes and the ancient varnishes is the abandonment of amber, juniper, and pine balsams, and resins, for the gums of the East. The peculiar properties of the balsam will be explained in the course of this lecture. I may say that what now follows is an investigation into the capacity of various oils and varnishes of resisting moisture, which brings us to some curious, and, I venture to think, new conclusions. Part of it has already been laid before the Society. I venture, however, to repeat it here, as it leads up to certain experiments which have been completed since the reading of that paper, and which, I think, throw further light on the methods of the old masters.

When we look at the Van Eyck, No. 186 in the National Gallery, we are at once struck with its wonderful state of preservation. The reds, probably produced by glazings of lac, or Brazil wood, or kermes lake, over a yellow or red ground, seem certainly to have slightly faded, and turned brown, when compared with fresh preparations of the same lakes made from the old recipes; but they are in a very fair condition, and the green on the wife's dress is marvellously brilliant. This green is worthy of special attention, as it seems to be agreed, among the authorities on these matters, that it can only have been produced by a glazing of verdigris, a pigment which we now know to be of a most dangerous character, turning black, and corroding and destroying other colours. The oranges in the corner are apparently painted with orpiment, another dangerous colour to use.

With reference to the reds, I have already mentioned the three lakes, which are most commonly referred to in old recipes, madder being hardly ever mentioned. Of these, Brazil wood is very fugitive, turning a dirty brownish red, and fading very much, if only exposed to sunshine for a few days. Lac lake, though better than the last, is not a permanent lake, and kermes, though better than lac, is not a permanent lake. Unfortunately these lakes, when prepared from the old recipes, are so much alike, that it is impossible to identify them on a picture. Judging, however, by these recipes, one lake is as likely to have been used as another.

In this picture, then, painted early in the 15th century, we probably have verdigris, a notoriously fugitive pigment, orpiment, a pigment very apt to change, and a lake which will fade with more or less rapidity, according to which of the three lakes above-mentioned has been used.

It cannot then be held, that the preservation

of the picture is due to the pigments used, and we must therefore look elsewhere for an explanation of its freshness.

If then the secret does not lie in the pigments it must be in the vehicle, and this leads us to consider what properties a vehicle must have to produce so remarkable an effect.

This question is very easily answered.

It has been again demonstrated by Prof. Russell and Captain Abney, in their report on water-colours (1888) that most fugitive pigments are permanent if protected from moisture, and a still larger number, if protected both from air and moisture. If, then, we can obtain a vehicle which will really protect the particles of the pigment from moisture, we may use with safety many pigments that are now regarded as fugitive.

At this point, one is apt to think that the inquiry is concluded, as we are accustomed to assume that ordinary varnishes and oils do preserve surfaces from the action of moisture; but, unfortunately, if a sufficiently delicate test is applied, this is not found to be so. The method I have devised for doing this is to use as a pigment ignited sulphate of copper, which is of course a very hygroscopic body. If we grind a little of the ignited sulphate with linseed oil, and paint it out on a glass slide, we get an enamel-like white surface, with sometimes a slight greenish tinge in it.

If this is placed in a dessicator to dry, it remains the same in appearance. If, however, when dry it is exposed to the air of a room, it gradually turns green and transparent; or, if it is exposed under a bell jar, beside a dish of water, the change takes place much more rapidly, twelve hours being often sufficient. If we now examine the slide under a microscope, we usually find that no definite crystalline formation is visible; but occasionally, here and there, are to be found complete crystals of sulphate of copper, due apparently to a slow aggregation of molecules in the colloid linseed oil.

I shall begin by describing the experiments I have made on linseed oil alone.

Linseed Oil.

The linseed oil of modern commerce differs in several important particulars from that used by the old masters. Hot pressed from adulterated seed, refined by the addition of sulphuric acid, and then probably further adulterated with other oils before it is put on the market, it is a very inferior product. The oil of the old masters seems to have been cold pressed from pure seed, and then refined by exposure to sunlight and washing with water.

In converting it into boiled oil, various substances and methods were used; such as exposure merely to the sun till it thickened; boiling with bone ashes and pumice; boiling it with ignited sulphate of zinc*; boiling it with litharge or with white lead, or with amber; or exposing it to the sun in leaden dishes, or mixed with white lead.

The modern practice is probably in many cases similar, salts of manganese having been added to the list, and such substances as sulphate of zinc having been abandoned.

My impression from the study of the old recipes is that, probably in most cases, litharge, or white lead, was used, just as it is most commonly used now. We have, then, to look rather to the earlier stages of the preparation of the oil, to find any serious difference between ancient and modern practices.

With a view to finding whether the capacity of linseed oil for resisting moisture would be improved by following any of the old methods, I tried the following experiments. I obtained—

1. A sample of ordinary pale drying oil of the best quality.

2. A bottle of drying oil from one of the leading firms of artists' colourmen.

3. A sample of Bell's medium from Messrs. Bell and Co., of Oxford-street. This medium is prepared by cold pressing carefully sifted seed, and then keeping the raw oil at a temperature of about 100° C. for some weeks, until it becomes thick and viscous. This "fat oil" is then thinned with oil of spike for use.

4. I obtained some raw oil, cold pressed from sifted English seed, which I then refined in the following manner:—A bottle was filled one-third full with salt water and sand, and one-third full of oil, and was placed in the sun, with a loose cap over the top, for four weeks. By the end of that time no more precipitate was formed, and the oil was drawn off, filtered, and converted into boiled oil by heating to 100° C. for 120 hours with borate of manganese.

Another portion, after refining, was converted into boiled oil, by heating strongly for three hours with bone ashes, adding ignited sulphate of zinc, and allowing it to settle and stand in the sun, according to an old German recipe which is quoted by Eastlake in his "History of Oil

* The use of this substance is probably accounted for by the fact that the crude sulphate prepared from the ore often contains manganese. The pure sulphate has no effect on the oil.

Painting." Slides were painted out with these different oils mixed with sulphate of copper, and after having been dried in a dessicator were exposed to moisture. They all turned green at approximately the same rate, and repeated experiments did not show that one had much advantage over another. If a slide is varnished with oil after being dry, it of course resists a little longer; but four layers of such varnishing only protect the slide for three days instead of one.

As far, then, as these experiments are concerned, there seems to be no reason to suppose that the pure oil, sun-refined, has much advantage over the commercial oil, or that the different methods of converting it into boiled oil exercise an appreciable effect. Only one point seemed to remain unsettled. It seemed possible that the old oil, imperfectly pressed, might be superior to that obtained by the hydraulic press. In order to test this, I had some fresh seed pressed, and took samples during the pressing, dividing the oil into three parts. Taking the first of these, I refined it, boiled it with borate of manganese, and tested it. The moisture penetrated through it as before.

These experiments seem to show, then, pretty conclusively, that linseed oil, no matter how pure, or how carefully refined, or in what way it is converted into boiled oil, cannot be depended upon to protect a surface from moisture. In the course of these experiments, I was struck with the fact that linseed oil which had been kept for some time, after it was dry in the dessicator, seemed to resist better than lately-dried oil, when exposed to moisture. Three weeks was found to make a considerable improvement, and two months still further improvement. These experiments are being continued, with a view to finding at what point the improvement will cease.

When we consider the nature and constitution of linseed oil, I do not think we need be surprised at its permeability to moisture. Besides containing linoleine, it also contains considerable quantities of non-drying fatty acids, which, being unaltered during the oxidation of the linoleine, must tend to produce a spongy and porous surface. According to Allen, the dried film contains free glycerine, which must not only tend to increase its porosity, but also to act as a carrier of moisture. Taking these different facts into consideration, the passage of moisture through linseed oil is not surprising.

I should like to refer here to a theory which has been recently advanced, that lead driers are injurious in pictures, on account of the formation of lead soaps. As far as these experiments are concerned, we have no confirmation of this; and I confess that the theory seems to me a very startling one, in the light of the fact that the white lead used by the old masters was prepared by the Dutch process, and therefore contained large quantities of lead hydrate, and of the fact that the oldest recipe I am familiar with for preparing drying oil, advises that this should be done by boiling with oxide of lead.

When Mr. Scott Taylor tells us that the Venetian painters were accustomed to grind their white lead repeatedly in vinegar, I can only suppose that chemists, like poets, are sometimes caught nodding. It seems to me more probable that treatment with lead salts may remove some of the fatty acids other than linoleic acid as lead soaps. I do not find, however, that the oil which rises to the surface of ground white lead protects from moisture any better than ordinary oil.

Walnut Oil.

Walnut oil is frequently referred to in the old recipes, and seems to have been largely used by the old masters for painting. It can be prepared by pressing the kernels of walnuts after slightly warming them. The walnuts should be about three months old. The oil obtained is very pale, and dissolves white lead freely on boiling, becoming darker in colour. I prepared a little by boiling the kernels of the walnuts with water, after pounding them in a mortar, roughly separating the oil which rose to the top, dissolving the oil in ether, filtering, and evaporating off the ether. I then converted this oil into a boiled oil, by heating it with white lead. On testing it with the sulphate of copper, I found that moisture rapidly penetrated, showing that it is no better in this respect than linseed oil. As these were the two oils which were used by the old masters, the protection of their pigments cannot have depended upon the nature of the oil used.

Resins.

In order to test how far pure resins will protect the sulphate of copper from moisture, I dissolved them either in spirits of turpentine or in benzole, ground the sulphate of copper with the solution, and painted it out on a glass slide. I have not attempted an exhaustive examination of resins, but have contended myself with a few typical ones, namely, colophony, mastic, Sierra Leone copal, and amber. The

varnishes were all prepared by first fusing the resin, and then gradually adding the spirits of turpentine to the fused mass.

The change of appearance on exposing one of the slides thus prepared to moisture was quite different to the appearance in the case of oil. The surface became an opaque greenish blue in the course of a few hours in the case of colophony, mastic and Sierra Leone copal, but after that there was no further change. On then examining these slides under the microscope this appearance was explained. The whole surface was rough and covered with blue cones of sulphate of copper with unaltered white plains between. Apparently the varnish on drying became full of small cracks or holes, through which moisture penetrated, but in itself resisted the passage of moisture. These holes were so close together as to give the whole surface a blue appearance when examined with the naked eye. The one exception to this was the amber varnish. It resisted the attacks of moisture for weeks without change. I think, however, that we may consider that such solutions of resins protect a surface from moisture sufficiently well for all practical purposes. The slight change taking place in the sulphate of copper does not go any further, and would, I think, be imperceptible in the case of a fugitive pigment.

I need hardly point out, however, that such solutions are quite unfit to be used as mediums in place of oil, and that the surface formed is brittle and not very durable.

Oleoresinous Vehicles.

Eastlake, in his "History of Oil Painting," devotes himself principally to trying to determine what medium was used by Van Eyck and his immediate followers. As his book is the most important work on this subject, and he has devoted immense pains to investigating all the documentary evidence, the theory he advances requires specially careful examination.

Briefly, his theory is this, that the Flemish painters ground their colours in oil, that they prepared a varnish by dissolving a resin, preferably amber, in oil, and that they mixed a little of this with the colour. He claims that such a medium protects the pigments from moisture, and that it is only necessary in the case of specially fugitive pigments such as yellow lake, verdigris, &c., to increase the proportion of varnish, and diminish the proportion of oil, in order to effectually lock them up and protect them from the action of a moist climate. This he calls the oleoresinous vehicle, and while, undoubtedly, showing that this in all probability represents their usual practice for ordinary pigments, I think he fails to make out that they relied upon this method in the case of notoriously fugitive pigments. In fact, curiously enough, as I shall presently show, any evidence he brings forward points in quite a different direction. At the same time he quotes from a sufficient number of authorities to show that he correctly describes their general practice; a practice for which there are sufficient reasons, apart from the question of the preservation of specially fugitive pigments.

It has been shown by Professor Church that even so hard a resin as copal, when dissolved in a volatile medium, after a year becomes covered with minute cracks; that this is also true of copal dissolved in the usual quantity of oil necessary to make a varnish. But he finds that if a copal oil varnish is fixed with a certain proportion of oil, it forms a surface which is hard, and therefore preferable to oil alone, which is soft, but which does not crack. There seems to be no doubt, therefore, that, apart from other considerations, the mixture of a resin dissolved in oil, with oil, produces the most permanent surface. It remains to be seen whether such a medium has the quality claimed for it by Eastlake of protecting the pigments from moisture.

In order to experiment upon this matter, I obtained (1) a very fine sample of a genuine copal varnish from Messrs. Freeman. (2) Mander Brothers, Coburg varnish. (3) I dissolved Sierra Leone copal in my own pure linseed oil, and heated it till it became stringy, as directed in the old recipes. (4) I dissolved amber in the same way in the pure oil. (5) I boiled some of the amber varnish, mixed with white lead till almost solid, and then diluted it with spirits of turpentine. I then prepared slides with these varnishes mixed with the sulphate of copper.

Comparing the slides painted with pure oil with slides painted with a mixture of oil and varnish, and slides painted with the varnish alone. In some cases, the slides, after drying, were varnished with the mixture that had been used in painting them out. In making these varnishes, I mixed about one-third resin with about two-thirds oil. None of these preparations resisted the attacks of moisture. Those containing varnish resisted a little longer than those merely containing oil; but the difference

was probably due to the greater thickness of the protecting layer.

As far, then, as we can judge, by the sulphate of copper test, Eastlake's theory that an oleoresinous vehicle will protect a fugitive pigment is not correct. It seemed to me necessary, however, to check these results by some experiments made in another way, and I therefore determined to try whether such mediums would protect a fugitive pigment.

In order to reproduce, as near as possible, the conditions necessary in the case of one of the old masters, I prepared some Brazil wood lake according to one of the old recipes, and, after careful washing and drying, ground it with the following mediums :—

1. Commercial pale boiled oil.
2. Rowney's boiled oil.
3. My pure oil.
4. The pure oil mixed with amber varnish.
5. The pure oil mixed with copal varnish.

All of these faded when exposed to sunlight, and apparently faded at the same rate.

To confirm this result, I next rubbed out on two glass plates carmine ground in pure oil. After the two plates were dry, I put one away in the dark and exposed the other to light. At the same time, I rubbed out on two other plates, carmine ground with pure oil and a little amber varnish, and exposed one of these to light. The two plates kept in the dark retained their brilliancy, while the two exposed to light quickly turned brown at the same rate.

I think that these experiments show pretty conclusively that whatever method may have been used to preserve fugitive pigments by the old masters, it cannot have been that of grinding colours with oil, and then mixing in a little oil-varnish, as supposed by Eastlake.

In order, then, to solve this problem as to the nature of the vehicle used to preserve fugitive colours, it is necessary to lay aside the theories of such writers as Eastlake, and examine carefully such old recipes as are available. This is all the more necessary as the word varnish is used so carelessly by writers on this subject, for they seem to think that all varnishes have similar properties, and therefore it does not matter whether the nature of the varnish is stated or not. To begin with, the oldest recipes we find—the varnishes—three mentioned are all oil varnishes. Besides oil, they contain amber, or sandarac, and a balsam, such as Venice turpentine (the balsam of the larch), or oleo de abezzo (the balsam of the silver pine). Very large quantities of these balsams were sometimes used. For instance, in one old recipe a varnish is recommended consisting of three parts Venice turpentine, three parts of oil, and one part of mastic; while in another recipe two parts of Venice turpentine to one part of oil is given. Such varnishes must be considered simply as balsams, slightly diluted with oil to make them flow better and give greater toughness to the surface. In other cases the varnishes do not contain these balsams.

Apparently the first spirit varnishes, by which I mean in this case varnishes formed by dissolving a resin or a balsam, or both, in spirits of turpentine or natural naphtha, were invented in Italy, and thence found their way back to Flanders, the first home of oil painting; but the records that have been left of the methods used by Van Eyck and his followers are so scanty, that we cannot speak with certainty on this point.

The first detailed account that we get of the methods of the Flemish painters is that given by De Mayerne, physician at the Court of Charles I., and a friend of Rubens and Vandyke. In the recipes given by him, Venice turpentine is frequently mentioned as a suitable substance for the preparation of varnishes, and he advises that it should be dissolved either in naphtha or spirits of turpentine, with the occasional addition of mastic, or with the addition of a few drops of oil to give it toughness.

Perhaps the most interesting of his recipes is the one in which he tells how verdigris can be preserved for ever without changing by heating it with Venice turpentine and spirits of turpentine.

The Italian painters seem to have preferred oleo de abezzo, as lighter in colour and quicker in drying, and in one of the recipes given in the Paduan MS. it is stated that amber can be dissolved in such a balsam. Apparently, in the time of Rubens, the custom had grown up in Flanders of varnishing pictures after they were finished, which was not done in the days of Van Eyck. Doubtless, therefore, the varnishes mentioned by De Mayerne in many cases are meant for covering finished pictures, but the recipe for preserving verdigris looks as if they were sometimes used for mediums. To carry down the tradition as to the use of Venice turpentine, it is only necessary to refer to the canvas of Sir Joshua Reynolds, in the possession of the Royal Academy, where the dab of paint labelled

gamboge, plus Venice turpentine, is perfectly fresh, while the dab labelled gamboge plus oil has completely faded. Many other examples as to the use of balsams might be quoted, but sufficient has been said to show the necessity of investigating the properties of such substances.

I have experimented upon three balsams, Venice turpentine*, Canada balsam, and the balsam of the silver pine. On testing with sulphate of copper, I found that Venice turpentine completely secluded moisture. Canada balsam did so for a long time, several weeks, but seemed to slowly yield. I have not tested oleo de abezzo in this way. When used as mediums, the addition of a very little oil, about quarter of the weight of the balsam, suffices to make it thin enough to grind colours in. Hard resins, such as amber and copal, readily dissolve in them, thus forming compound varnishes. The best picture varnish I have been able to make is copal dissolved in Venice turpentine and diluted with turps or with naphtha.

The oleo de abezzo is a beautiful pale yellow balsam, and forms a varnish quite equal to mastic, with, however, a slight tendency to bloom. They are all brittle when dry, but a very small admixture of oil gives the necessary toughness.

I find that carmine, ground in Venice turpentine or in oleo, with a few drops of oil, preserves its freshness wonderfully. On exposure to sunlight the purple bloom quickly goes, but after that the colour remains strong and good, while becoming a dirty brown and fading in oil or an oil varnish. I find that if verdigris in oil be exposed to sulphuretted hydrogen gas it turns black in a few minutes, while verdigris in balsam is only very slightly affected after some hours.

There is another important property revealed by these balsams which requires some explanation. I find that certain pigments dissolve more or less readily in linseed oil. For instance, emerald green dissolves slightly, and diffuses through the oil even after it is dry. If, for instance, emerald green is painted over dry cadmium yellow with a layer of dry oil between, it gradually passes through, and after a few months attacks the cadmium yellow and turns it black.

* I obtained a sample of genuine Venice turpentine with some difficulty in London. Through the kindness of the Curator of the Cambridge Botanical-gardens I obtained some larch balsams from trees there, and some balsam of the silver pine from the Black Forest.

Verdigris is still more soluble. If warmed with linseed oil it gives a green solution. If verdigris in oil and cadmium yellow are mixed together, the action of the verdigris is so rapid that in a few hours the whole thing has turned black. Now, if instead of oil these pigments are ground in a balsam, even though a few drops of oil are mixed with it, this does not happen. A light green can be made with them perfectly well, which, as far as I have tested it, is durable.

I hold then that both the historical and experimental evidence shows that these balsams were used for varnish and mediums, in some cases being used pure or almost pure. The point to be noted is that the harder the resin, the more oil is required to dissolve it and make a fluid varnish. Consequently amber was unsuitable for the preservation of pigments such as verdigris. On the other hand, for other purposes, amber may have been used. With amber, sandarac, and the balsams, a whole range of varnishes could be easily prepared, suitable for different purposes, the first of the series containing a great deal of oil, the last being nearly pure resin. In fact, in some recipes I find the hot balsams recommended as a varnish by itself; and in one old recipe balsams are mentioned by themselves, as the right tempera for colours. The evidence of Dr. Mayerne is also very conclusive on this point, especially in his recipe for the preparation of verdigris; and this theory is certainly borne out by the appearance of the old Dutch and Flemish pictures. Probably the use of balsam was more excessive in the Flemish pictures than in the Italian pictures meant for a drier climate.

You will ask, if this theory of mine is correct, how does it apply to modern painting?

I do not, as yet, see how to apply it. These balsam vehicles are sticky, and quite unsuitable therefore for modern work. I think, however, that it indicates to us very clearly the direction in which to work, to improve our present oil mediums. I shall, at present, continue my experiments on varnishes prepared from fine resins and balsams. The varnish I have used for the gilding of the tinfoil has been prepared on these lines. I find that the melted balsam not only dissolves amber, but also dragon's blood, saffron, and aloes, and, I do not doubt, will protect them from change. Much, however, requires to be done before a satisfactory varnish can be prepared from them.

In the course of these three lectures I have

said something on panels, on pigments, and on vehicles. I have purposely said nothing on canvases, as I do not feel competent at present to discourse about them. Nor have I exhausted the list of ancient pigments. I have confined myself to those of most importance.

I think you will feel with me that no royal road has been discovered by which durable pictures can be painted. On the other hand, I think you must have been impressed by the marvellous amount of ingenuity expended on this question by the old masters, and the skill with which they handled it.

Many hints, useful practical hints, may be derived from their practice, but it cannot be applied directly to modern work. The conditions are entirely different. The artist of to-day must have his pigments ground so that they are perfectly free under the brush, and he must be able to mix them without a thought as to how far they are compatible one with another. His picture is an inspiration, it is not slowly and carefully built up, he refuses to be trammeled by the traditions of the house painter. Consequently, he throws upon the chemist the burden of solving a problem much more difficult than the one of the past.

The first step is, I believe, rigid exclusion of dangerous pigments, and careful preparation of those retained. The next is careful preparation of the oil and the varnish used.

I find oil properly prepared stands wind and weather better than that usually sold. Exposure for twelve months, without varnish, outside, and to all the sun and rain, &c., does not seem to hurt it. The oil with which pigments are usually ground does not stand such a test. In this oil a suitable resin should be dissolved to make a varnish.

So much decided on, we can begin our search for an improved medium. A medium that will isolate the pigments one from another, and protect them from external influence, as the balsams do, and at the same time work freely beneath the brush. This is, I think, the main problem before us.

FOREIGN & COLONIAL SECTION.

Tuesday, January 12, 1892; Sir THOMAS WADE, G.C.M.G., K.C.B., in the chair. The paper read was "The Laos States of Upper Siam," by Ernest Satow, C.M.G.

The paper and discussion will be printed in the next number of the *Journal*.

Obituary.

EARL OF LICHFIELD.—Thomas George Anson, second Earl of Lichfield, died at his town house on Thursday, 7th inst., aged 67. He was, for a time, Member of Parliament for the city of Lichfield, and succeeded to the Earldom on the death of his father in 1854. In the early stages of the reformatory movement, originated in Birmingham by the late Matthew Davenport Hill, Lord Lichfield took an active part in the formation of public opinion on the question. He was the first chairman of the Society for the Reformation of Juvenile Offenders, and took part with Lord Norton (then Sir Charles Adderley) and others in establishing the reformatory at Saltley. Lord Lichfield was elected a Member of the Society of Arts in 1867, and held the office of Vice-President in 1871.

General Notes.

CHICAGO EXHIBITION.—The New Year's number of the *Chicago Herald* (Friday, Jan. 1) contains a paragraph on the Columbian Exposition in all living languages, including Persian, Arabic, Turkish, Armenian, modern Greek, Chinese, Japanese, Hindostani, Syriac, &c. This number also contains illustrations of the condition of the various buildings in the grounds as they appeared on December 22, 1891.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 20.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention." Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

JANUARY 27.—F. W. EDRIDGE-GREEN, M.D., "The Scientific Value of Lovibond's Tintometer." R. BRUDENELL CARTER, F.R.C.S., will preside.

FEBRUARY 3.—T. PRIDGIN TEALE, "Dust, and How to Shut it Out." Dr. T. E. THORPE, F.R.S., will preside.

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

FEBRUARY 17.—Capt. F. E. YOUNGHUSBAND, "The Pamirs."

Papers, the dates of reading of which are not yet fixed:—

"Iceland." By TEMPEST ANDERSON, M.D.

"Ancient and Modern Art Pottery of Japan." By ERNEST HART.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Durability of Pigments Ground in Oil and other Vehicles." By A. P. LAURIE, M.A.

"Manufacture and Industrial Application of Flexible Tubing." By GILBERT R. REDGRAVE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

FEBRUARY 16—LEWIS ATKINSON, "The Kimberley Exhibition." 8 p.m. The paper will be illustrated by lantern slides.

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru."

Papers, the dates of reading of which are not yet fixed:—

"Australasia." By Sir EDWARD BRADDON, K.C.M.G.

"Newfoundland." By Sir WILLIAM WHITEWAY, K.C.M.G.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

JANUARY 21.—HERBERT JONES, "From Tien-Shan to the Pamirs—experiences on the Russo-Chinese Frontier." Sir WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D., will preside. The paper will be illustrated by lantern slides.

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-General Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

JANUARY 26.—WILLIAM MORRIS, M.A., "The Woodcuts of Gothic Books." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., will preside. The paper will be illustrated by lantern slides.

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets."

MARCH 8.—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE T. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

LECTURE I.—JANUARY 25.—Low pressure supply—Comparison between 1885 and 1892—Central stations *versus* isolated plants—Electricity *versus* gas—Cost of feeders and distributing mains—Management of feeders—Use of recording apparatus—House wiring—Three-wire system—Five wires—Use of motor-dynamos as compensators—Batteries—Conductors.

LECTURE II.—FEBRUARY 1.—High-pressure supply—Old attempts—Alternate currents—Transformers—Feeders—Sub-stations—Overhead and underground conductors—Generation of electricity by power obtained at a distance from (1) electricity, (2) gas, (3) compressed air, (4) water under pressure—Load factor—Waste products.

LECTURE III.—FEBRUARY 8.—Transmission and distribution of electricity derived from lighting circuits—Effect on load factor—Separate circuits for power—Distribution for street and other railways—Utilisation of water-power by electric transmission to a distance.

LECTURE IV.—FEBRUARY 15.—Generators of electricity by water-power and by steam obtained from destructors—General account of destructors—Hydraulic accumulators—Utilisation of local circumstances—Probable developments of electric distribution in the immediate future.

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.
February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.
March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bateriology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday evenings, at Eight o'clock, by PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

February 5, 12, 19, 26, March 4, 11.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 18...Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. E. H. Morris, "The Four-Course System, with desirable Variations."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. 1. Discussion on "Amended Suggestions for the Conduct of Architectural Competitions." 2. Address to Students, by Mr. J. Macvicar Anderson, President.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. W. J. Slater, "The Weak Side of Natural Selection."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. B. Tylor, "Recent Information as to the Lower Races of Man."

TUESDAY, JAN. 19....Royal Institution, Albemarle-street, W., 3 p.m. Professor V. Horsley, "The Brain." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Wilfrid Airy's paper, "Weighing Machines."

Statistical, Geological Museum, Jermyn-street, S.W., 7¾ p.m. Mr. L. L. Price and Dr. J. C. Steel, "The Recent Agricultural Depression, as exhibited in the rental of an Oxford College, and the financial position of a leading London Hospital."

Pathological, 20, Hanover-square, W., 8½ p.m.

WEDNESDAY, JAN. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Vivian B. Lewes, "Spontaneous Ignition of Coal, and its Prevention."

Meteorological, 25, Great George-street, S.W., 7 p.m. Annual Meeting.

Geological, Burlington-house, 8 p.m. 1. Rev. Edwin Hill and Prof. T. G. Bonney, "The Hornblende-schist, Gneisses, and other Crystalline Rocks of Sark." 2. Arthur Wm. Walters, "North Italian Bryozoa.—Part II. Cyclostomata."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual Meeting. Address by the President, Dr. R. Braithwaite.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. J. Nesbit, "Stereoscopic Photography."

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President, Mr F. D. Godman.

Archælogical Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 55, Chancery-lane, W.C., 7½ p.m. 1. Discussion on Mr. Abel's and Mr. Loubier's papers. 2. Mr. A. V. Newton, "Patent Agency: its Origin and Uses." 3. Mr. G. B. Ellis, "Compulsory Licenses."

Civil and Mechanical Engineers, 7, Westminster Palace Hotel, S.W., 7 p.m. Mr. H. Coward, "Forced Ventilation by Compressed Air."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, JAN. 21 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Herbert Jones, "From Tien-Shan to the Pamirs: Experiences on the Russo-Chinese Frontier."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8 p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. D. Morris, "Additional Notes on the Tick Pest in Jamaica." 2. Mr. F. E. Weiss, "The Development of Caoutchouc-containing Cells of Eucommia Ulmoides, Oliver." 3. Dr. Jean Muller, "The Lichens of Manipur."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. M. A. Adams, "The Estimation of Oxygen in Water." 2. Messrs. P. F. Frankland and W. Frew, "A Pure Fermentation of Manitol and Dulcitol." 3. Prof. V. B. Lewes, "The Luminosity of Coal-gas Flames." 4. Mr. W. Ostwald, "The Magnetic Rotation of Dissolved Salts." 5. Mr. W. Ostwald, "The Dissociation of Liquid Nitrogen Peroxide."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Carl Armbruster, "The Wagner Festival Performances at Bayreuth." (With illustrations.)

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. S. Murray, "Some Aspects of Greek Sculpture in Relief." (Lecture I.)

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, JAN. 22 . United Service Institution, Whitehall-yard, 3 p.m. Colonel Gouraud, "The Phonograph for Naval and Military Purposes."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Rayleigh, "The Composition of Water."

Philological, University College, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. G. T. FitzGerald, "The driving of Electromagnetic Vibration by Electromagnetic and Electrostatic Engines." 2. Prof. S. P. Thompson, "Supplementary Colours."

SATURDAY, JAN. 23 ... Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Prof. A. W. Rücker, "Electricity and Light." (Lecture II.)

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m Prof. J. R. Fleming, "The Induction Coil and Alternate Current Transformer."

Journal of the Society of Arts.

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FRIDAY, JANUARY 22, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

H.R.H. THE DUKE OF CLARENCE AND AVONDALE, K.G.

At their meeting on Monday, the 18th inst., the Council of the Society resolved that the following letter be addressed to H.R.H. the Prince of Wales, the President of the Society:—

To H.R.H. The Prince of Wales, K.G.,
President of the Society.

Sir,—The Council of the Society of Arts desire on their own behalf, and on behalf of the Society over which you have presided now for twenty-eight years, to express to your Royal Highness the feeling of profound sorrow with which they have received the sad news of the death of His Royal Highness the Duke of Clarence and Avondale.

His Royal Highness had been, since 1885, a Vice-President of the Society, and the Council had every reason to hope that, in years to come, he might have co-operated with them in carrying on the many works of public utility, for the promotion of which the Society was established, and that they might have received from him the same judicious guidance, the same wise counsel, that they have received from your revered father, and from yourself.

These hopes have been shattered by his sudden and untimely death, and there remains to the Council but the melancholy duty of offering to your Royal Highness, in your bereavement, this expression of their sincere and heartfelt sympathy, and this record of their sense of the special loss which the Society has suffered by the death of him for whom the whole nation is now mourning.

Sealed with the Seal of the Society for the Encouragement of Arts, Manufactures, and Commerce, this Eighteenth day of January, 1892, in the presence of (L.S)

Richard E. Webster,
Chairman of Council.

Henry Trueman Wood,
Secretary to the Society.

MUSICAL EXAMINATIONS.

Sir John Stainer has been appointed Examiner in Music to the Society, and Mr. W. G. M'Naught Assistant Examiner.

ORDINARY MEETING.

In consequence of the funeral of H.R.H. the Duke of Clarence, a Vice-President of the Society, the meeting announced for Wednesday, 20th inst., was not held.

The paper by Prof. Lewes, set down for that meeting, will be taken at the meeting on March 2nd.

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Monday, 18th inst. Present:—The Attorney-General, M.P., in the chair; W. Anderson, D.C.L., F.R.S., Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., M.P., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, Lord Alfred S. Churchill, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., Major-General J. F. D. Donnelly, C.B., James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. Malcolm Kennedy, C.B., John Biddulph Martin, W. H. Preece, F.R.S., Sir Owen Roberts, M.A., F.S.A., Prof. W. C. Roberts-Austen, C.B., F.R.S., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, as Secretary.

METALLURGICAL COLLECTION.

The Royal Commission for the Chicago Exhibition are endeavouring to form a typical collection illustrating British Metallurgy for the British Section, and they are now applying to Owners and Managers of Metallurgical Works asking for specimens of each of the principal metallurgical products produced at the works, and also for specimens illustrating various processes.

Dr. E. J. Ball, the Instructor in Assaying at the Royal College of Science, South Kensington, has kindly undertaken to classify and arrange the Collection, and specimens may be addressed to him.

Specimens of special value or rarity are not expected, but samples are desired of Metals,

Regulus, Slags, Alloys, &c., so that the Collection when complete may be fully illustrative of the condition of metallurgy in the kingdom. Samples of metal sent should, where possible, be freshly fractured, and attention should be paid to any special unmanufactured products for which a market is desired.

At the close of the Exhibition the Collection will be presented to an American museum, so that it will have a permanent value.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, January 12, 1892; Sir THOMAS WADE, G.C.M.G., K.C.B., in the chair.

The paper read was—

THE LAOS STATES, UPPER SIAM.

By ERNEST SATOW, C.M.G.

The northern and eastern portions of the dominions which acknowledge the sway of the Siamese king are known to geographers as the Laos, from the Siamese name of their inhabitants. Along the banks of the Mĕkhong, or Cambodia River, these populations, though governed by officials of their own race, are directly subject to Bangkok, but in the north they are divided into six States, ruled over by their hereditary chiefs, and thus are semi-independent. These six States are Chiengmai, Lamphun, Lakhon, Nan, Phrĕ and Luang Phrabang. In the first five, Asiatic subjects of the Queen, chiefly natives of Burma, have for many years carried on an extensive trade in teak timber, taking leases of the forests from the chiefs and other owners. Almost from the very commencement of the diplomatic relations with Siam, which followed upon the conclusion in 1855 of Sir John Bowring's treaty of commerce, disputes and lawsuits began to arise in onnection with the rights thus obtained. In 1874, a treaty was negociated between the two kings of Siam and the Viceroy of India, which had for its principal object the establishment on the spot of tribunals for the determination of such disputes, but having failed in completely securing the objects aimed at, it was superseded in 1883 by a fresh treaty concluded between Great Britain and Siam. Under the new treaty a native court was created at Chiengmai for all cases, both civil and criminal, in which British subjects were either plaintiffs or defendants, and a Vice-Consul was appointed to reside there, to watch over the execution of its provisions and to protect the interests of her Majesty's subjects. The Judges of the Court were Siamese, and a Commissioner was in addition appointed by the King of Siam to discharge functions similar to those of the British Resident at a native court in India. At first the treaty applied only to Chiengmai, Lamphun, and Lakhon, but its operation was afterwards extended to Nan and Phrĕ. The arrangements looked well on paper, but owing to the vast amount of arrears which had accumulated in consequence of the failure of the Treaty of 1874, they did not work smoothly; so that it became advisable for me to pay a visit to Chiengmai, in order to make myself acquainted with the causes which impeded the settlement of the outstanding claims, and to gain personal insight into the circumstances and condition of the teak trade. Having obtained the sanction of her Majesty's Secretary of State for Foreign Affairs, I started on my journey towards the end of 1885, and spent nearly three months in travelling through regions which have seldom been traversed by Europeans, and still more seldom described.

The usual route to Chiengmai is up the western tributary of the Menam to Rahĕng, and thence by elephant through Lakhon, or by boat up the rapids. But I had been told, on what seemed to be excellent authority, that the voyage up the eastern branch to Utaradit, and thence by land through Phrĕ, Lakhon, and Lamphun, was really much shorter, which doubtless is true when there is plenty of water in the river and if one travels through without stopping. This year, however, the water had fallen below its usual level, or rather had never attained it during the rainy season, so that the launch could not get so far as Utaradit, and for the latter portion of the way we had to pole our heavy boat against the current.

Within a few hours after my arrival I received a visit from the King's Chief Commissioner, Phya Monkri by name, a man of about forty, strongly built, and with a pleasing countenance. During my stay, which lasted a whole month, I had frequently occasion to see him on business, but of that I shall say nothing in this journal. He goodnaturedly offered to do anything in his power to render my sojourn agreeable, and afterwards fulfilled his promise in a way that proved his words to be more than a mere compliment. Of this official I shall always retain a most agreeable memory.

On the following morning a son of the Chief

and one of his nephews, the latter an extremely intelligent young fellow, named Chao Landokmai, came to call, and after they were gone I went to return the Chief Commissioner's visit at his official residence, a large native building not far from the Vice-Consulate. Here I made the acquaintance of Phra Uphai, the principal judge of the Court established by the Treaty of 1883 for trying cases between British subjects and those of the King of Siam, among whom the Laos are naturally included. He turned out afterwards to be a very amusing fellow, full of legal stories, and I regretted very much to be unable to converse with him in his own language. In the afternoon I called on Dr. McGilvary and Mr. Martin, two American missionaries, the former of whom has been established here a long time, and on Dr. Cheek, who, originally a medical missionary, has now gone into the timber business. He speaks Lao like a native, and is a very cultivated man into the bargain. I took a great liking to him, which was increased by a four days' tour we took together among the mountains, and we ultimately made the journey down the Mĕ Ping to Bangkok in company.

I had now only to make the Chief's acquaintance, which I did on the following afternoon. He lives in a fine house built in semi-European style, and is a jolly-looking old fellow of sixty-seven, not without a certain measure of native cunning, but intensely ignorant. The furniture was European, and on the floor were spread a number of gaudy Brussels carpets. The conversation turned upon the obstruction to navigation caused by the rapids in the river on the southern boundary of his territory. He would not believe that dynamite could be used to destroy rocks. Small boulders could be removed, but the bigger ones—never. There is no doubt that he looks upon the rapids as a heaven-bestowed barrier against aggression from the South, and it is certain that but for their existence the independence of the three Lao States would long ago have become a mere tradition. But some day a railway may be constructed up the Mĕnam valley, and then we shall witness the complete incorporation of Chiengmai with Siam.

On the next day he returned my call at the Vice-Consulate, arriving there in a sort of shabby victoria drawn by one pony. This is one of the two carriages that Chiengmai boasts of, and it is in constant use for official visits. On this occasion I puzzled the Chief very much by asking the name of a tree we have in the Legation grounds at Bangkok, which tradition says was brought from Chiengmai by Sir Robert Schomburgk about twenty-five years ago. I described through the interpreter the flower and leaf, but he would not recognise it, and at last became quite angry at being asked what he evidently thought was a most foolish question. "Why," said he, "all trees have flowers; how should I know." Then we got upon the subject of orchids, which seemed to interest him very much more. There are perhaps a hundred and fifty species found in the Chiengmai woods, and the women are very fond of wearing them as ornaments for their hair; the same practice is common in Burmah. Many of the better-known species have their distinctive native names. There is one which is brought every year from Muang Yuom by the Lawas who inhabit the mountains, and presented to the Chief as tribute. It has an insignificant greenish white flower, but is much esteemed for its fine odour, which the Chief asserted could be recognised in the city while the tribute-bearers were still several miles off. But the specimens I saw had a very faint scent. I asked him what there was in his dominions particularly worth visiting. Well, there was an ancient temple at a place called Chom-tong, distant about two days journey on elephants, that I ought certainly to see. I could take it on my way down to Bangkok. Then there were some hot springs at the village of Ban Punkum, near Doi Saket, some distance to the north-east. Until within a few years ago the water used to leap into the air with a loud noise. Then I ought to visit the pagoda halfway up Doi Su-thĕp. I asked him about Doi Chieng-dao. Well, the people used formerly to ascend it, but it is now inaccessible. He did not know why, but the Laos could not go up any longer. The *Phi* (spirits) would prevent them.

Of all unlikely places in the world where an evening suit could be needed, I had thought Chiengmai was one of the most improbable. Great was my horror, then, when I received a formal invitation to dine with Phya Monkri, and learnt that as the Chief would be there, a tail-coat was expected of me. Luckily, I had a black morning coat amongst my baggage, and my host was induced to accept it as a substitute for the garment prescribed by our etiquette. He has a pleasant private residence in the city, built of teak, and surrounded by a pretty garden. The drawing-room and dining-room were completely furnished in simple European style, and the dinner was provided

by a Chinese cook. One of the best dishes was Siamese curry, which I prefer to all others that I have tasted. The predominant flavour is derived from lime peel, and it is very pungent, owing to the free use of chilies, but there is nothing in the world that comes up to it, not even the prawn curry of Ceylon. Phya Monkri is a man of taste, and his verandah was hung round with ferns and orchids. He is fond of bric-a-brac, and had already collected some fine Buddhist bronze statuettes, several of which were extremely ancient. His spittoons of silver repoussé work, eighteen or twenty inches in height, were magnificent, and cigars were handed round in a gold box such as the Chinese workmen of Canton are famous for.

The city of Chiengmai covers a considerable area, and consists of two portions, the original city being square, enclosed by a high wall and a moat, round two sides of which a more modern extension has been added.

By far the most remarkable sight which Chiengmai affords is the early morning market. To this between two and three thousand women flock in every day from the surrounding country, each bringing her small supply of goods for sale, and coming in some cases from long distances, even as far as from Lamphun itself. They line both sides of the road leading up to the outer western gate, the first part of the main street to the second gate, and from the cross roads in the centre of the city they spread right and left for a long distance. Their wares are laid out on mats spread on the ground, behind which they squat in little groups of twos and threes. No shouting or loud-voiced chaffering over sales, as is the case with the Siamese market women in Bangkok. The stock-in-trade of a group seems to be of no great value; a few half-dried chilies, some bundles of cut tobacco, three or four pieces of petticoat cloth, a pile of buffalo-hide wafers sprinkled with sesame seed, or a few pounds of pork, would furnish out half-a-dozen of them. It is seldom that you see either fish or rice exposed for sale, and I have no idea where the people who deal in these principal articles of food are to be found. The only shops in the town are small booths, which line the street between the first and second gates, and here you may buy English cotton goods, yarns, and lacquered boxes from Burmah. In the cross street outside, which runs northwards and parallel to the river, you can procure a few vegetables and miscellaneous European goods from Chinamen or their native wives. The shops inside the walls seem to be mostly in the hands of the Burmese men and women. There are two European stores outside the town, one kept by an Italian, the other by a German, the latter having his place of business on the left bank of the river. Rupees are the universal currency. The city is laid out on the same principle as Phrĕ, Lakhon, and Lamphun. You can hardly see the houses for the trees. Each dwelling stands in its own garden of fruit trees, including a fair proportion of areca palms. A Lao city is like an assemblage of rural suburbs turned outside-in, and intersected by green lanes. The best theory is that the walls are intended solely as a refuge for the population of the province in time of war, and not as its usual place of habitation. The Chief's palace is naturally inside, as are also the houses of his numerous relatives, many, if not most, of whom occupy official posts. Artisans of merit have no freedom. As soon as a man becomes noted for skill in silver *repoussé* work or the manufacture of lacquered boxes, he is overwhelmed with commands from the Chief and his relations, who pay little or nothing for the labour they thus monopolise. Consequently, anything like a healthy development of the natural artistic capacity of the people is not to be expected, and there are no shops where you can buy their productions. You must supply a silversmith with rupees, and wait your turn until he can find time to work the silver up into the cup or basin you require.

One morning I went out riding with Phya Monkri, to visit an old temple in the centre of the town, and to inspect the process of lacquering. The Wat Phra Sing stands almost in the centre of the town, in a line with the eastern and western gates. The story goes that the principal image here enshrined was being carried, soon after its completion, across the town to be deposited in a temple that had been built to receive it on the opposite side, but on reaching this spot apparently declined to proceed any further. No efforts of the porters were sufficient to move it a single inch beyond. They left it for the night, and next morning it was found with its face towards the street by which it had come. This was looked upon as an interposition of the Buddha himself, and no further attempt was made to resist his will. A temple was consequently built over the image, and the main street was deflected so as to pass round it. There are signs that laterite was largely employed in the original construction. On entering the enclosure, the gateway of which is obstructed, as is usual in the Lao

States, by a solid log supported on two posts (something like the wooden horse of a gymnasium), you see before you a low wooden building, the gable of which, fronting towards the entrance, is decorated with tinsel. Its uprights and cross-beams are much out of line. It has the usual arrangement of several graduated roofs succeeding each other along its length, but the sides are enclosed by walls pierced for windows, which is not general. The doorway is guarded by two five-headed nagas in chunam. The pillars which support the roof are decorated with tinsel and stucco mouldings. This building is said to have been at one period the audience-hall of a chief; if so, it would seem to be a reasonable supposition that in earlier times the architecture of temples was the same as that of palaces. I was told that formerly it was the custom, on the death of a chief, to present his house to a temple. No doubt it had to be removed and re-erected in the temple grounds, otherwise the priests would, in the course of ages, have come to possess all the land in the city. Under the caves were some excellent carved triangular wooden brackets, the upper part of which was occupied by one, two, or three nagas, the involution of the serpents being cleverly managed, while the lower part was filled in with open work carving having a conventional design. This building is the *wihan*. Behind and at right angles to it stands a chapel containing an elaborately modelled brick and chunam shrine open on its four sides, having a sitting Buddha in the centre. The interior walls are decorated with paintings in monochrome, depicting scenes in heaven and hell.

The third chapel, in which is enshrined the Phra Sing, has been but recently restored. Its exterior is decorated with heavily gilded carvings, while the interior walls are covered with paintings on plaster, representing a variety of lively scenes, both architectural and landscape. The precious image whose obstinacy led to the foundation of this temple, is contained in a solid *dagoba*-like vaulted brick building in close connection with the chapel. This is entered from what is usually the seat of the Buddha's effigy in other sacred buildings, and is closed by an iron door. The walls and ceilings are thickly covered with gold leaf, as is also the image itself, which represents the Founder, sitting cross-legged with the left arm folded across the lap, while the right hand hangs over the knee. The countenance is more characteristic and individual than is usually the case with Buddhist images in Siam. On the base is an inscription in incised characters of the early type, found at several other temples in Northern Siam, rendered almost indecipherable by the excess of gilding. The image, which is between three and four feet in height, reposes on a square pedestal of stuccoed brick, painted black. Its age was said to be about three centuries, but, in the absence of any trustworthy chronology amongst these people, it might be of any period previous to the resettlement of Chiengmai by the Lakhon princes. The superior type of face, however, is in itself an argument in favour of a considerable antiquity. Close by this chapel stands a ruined *phra-chedi*, the base of which is surrounded by figures of elephants, presenting the front towards the spectator, in style similar to one which exists at Sawankhalôk. To the right of the *wihan*, just described, is the *hô-tam*, or library of sacred books, a small but comparatively lofty building, to which access is obtained by two flights of steps. Its lower story is adorned with lifesize chunam figures of *Thepha-phanom*, or angels.

We also visited the residence of the late Uparat, or heir-apparent. Part of the buildings have been pulled down since his death, but the principal one still remains. It is the largest house in Chiengmai, probably not even excepting the palace of the Chief. Bands of carving in geometrical patterns run round both exterior and interior. The beams and side brackets are all carved. Gigantic pillars of teak wood, smoothed with the native knife-sword, support the roof of the audience-hall, and here, as elsewhere, the use of saw and plane seems to have been unknown at the date of its erection. At the further end of the hall, on feet modelled as elephants and tigers, stands a handsome wooden screen; its front has a peacock in low relief facing towards us with its tail spread, while other animals, as dogs and tigers, very small in proportion, play about its feet. Behind the screen is a doorway, affording access to the other portion of the building, which is entirely without windows. At the near end of it stands a huge wooden cupboard several feet higher than the floor, which formed the state bedroom of the Uparat; being entirely covered in with planks, there was no provision for the admission of air or light. Its occupant must have felt it possible to sleep securely and soundly. This is said to be the normal style of construction for

Lao bedrooms. The eaves of the roof, which come down very low and render the interior extremely obscure, are supported by wooden brackets, carved in the form of the fabulous bird *Krut*, the Indian Garuda.

We rode along the southern street through the market, where women were engaged in cutting up and selling the carcases of pigs, and out by the Chiengmai Gate to a village occupied by Chieng-tung Shans, engaged in the lacquer manufacture. These people, or their forefathers, were taken prisoners in war, and in accordance with the custom of Indo-China were forced to migrate into the dominions of their conquerors. Men, not territory, are the prize of successful warfare in these countries. In appearance, costume and language, they do not differ from the Laos, but their accent is said to be unlike that of the Lao inhabitants of Chiengmai.

The form of the lacquered articles produced by these people is either cylindrical or cup shaped. The core is of fine bamboo basket-work, coated with lac, or with lac mixed with the ashes of straw. When the lac is dry, the basket is turned on a very simple lathe, the wheel of which revolves backwards and forwards, the principle of the crank being apparently unknown. In place of the more scientific appliance, the workman uses a treadle, which turns the wheel one way, and it is brought back in the opposite direction by a long bamboo which acts as a spring. The tool employed for smoothing is a bent chisel, sharpened at the end and sides of the bend. After the process of shaving has once been performed, fresh lac is applied, and it is shaved again; for the finest work this is repeated as many as twenty times. After being turned, the surface is polished with a piece of fine grained reddish stone of a sandy texture. The natural colour of the lac when dried is black. After the coating has reached a sufficient thickness, the required design is drawn on it by means of an ordinary double-ended tool, and lac, coloured red with vermilion, is rubbed into the pattern thus obtained. Finally, the completed article is polished by covering it with a mixture of lac and vegetable oil; the polish is simply smeared over with the finger and left to dry. The drying takes place on a shelf closed by a curtain, and the vapour of water is not, as in Japan, considered necessary. The lac is obtained from a tree which is certainly not the *Rhus vernicifera*, and I am inclined to believe that the process and the materials employed do not differ from those used in the similar manufacture which is carried on in Burmah. For my own part, I consider the Burmese article to be superior to what is produced in Chiengmai. One of the workmen who was engaged on a cylindrical box about 8 inches diameter and 3½ inches high, said that he would receive a rupee and a half for his labour, but that the completed article would fetch ten rupees in the bazaar. The designs are drawn from memory, and consist mainly of conventional flowers and leafage, with sometimes a bird introduced, the peacock appearing to be a favourite.

I am sorry that I could not find time to visit the silversmiths who live in the same part of the city. Their work is of two sorts, incised and *repoussé*. The latter is said to be produced by hammering on the outside of a thin sheet of metal formed into the required shape, and filled with resin, and the pattern is thus brought out by a process of indentation. But it will be better not to accept this, without reservation, as a correct account.

On the 15th of January I dined with the Chief, who had courteously allowed me to fix the hour; I chose seven o'clock, but as the word had previously been passed to the cook to have everything ready by six, we found all the dishes cold when we sat down, except the soup and Siamese curry. The other guests were Mr. Gould and Mr. Archer, of H.M. Consular Service, the Siamese Commissioner and Luang Suriya, the Judge of the International Court, and some younger members of the Chief's family. We sat on chairs at a long table, arranged in the European style, and were provided with knives and forks. The natives eat with their fingers as a general rule, but this was a special occasion. Fried wafers of cow and of buffalo hide were served with a sauce composed of fermented tea leaves, pork fat, onions, and a fourth ingredient which I do not recollect. A pile of these wafers was placed between the Chief and myself, and we dipped by turns into the same sauce-bowl. He was evidently pleased to find that I could eat them. You can offer no more delicate flattery to an Oriental than to partake of his native food. Though rather greasy, these preparations of skin were not unpalatable, especially a spongy variety which was well toasted. The conversation was heavy, until someone started the subject of Burma, and the Chief's eyes glittered with delight as he called to mind how his people had pursued a Burmese pretender, who appeared in Chiengmai some years ago, and killed one or two of the impostor's

followers. The old man would not believe that the British forces had taken Mandalay; the whole story was too incredible. As if any European could have conquered the great kingdom of Burma, which had been too much for the Laos themselves a hundred years ago, with so little difficulty. Moreover, our own Burmese subjects in Chiengmai disbelieved the rumour. It had been invented in Chiengmai itself by the foreigner who sat in a hut at the end of a wire and pretended to be in communication with Bangkok. Everyone knew that it was impossible. After dinner we admired his collection of gold boxes and basins of *repoussé* work, kept in a series of glazed cupboards at the back of the room, many of them very large and heavy, and probably ancient. They are the handsomest things of the kind I have seen in Siam, and the intrinsic value of the mere metal must be several thousand pounds. His crown, a gift from the King of Siam, was also produced. It is a pyramidal arrangement, like that of the king, only wanting (I was told) certain feathers, and is covered with small rubies and other precious stones.

Another day I rode out with the Chief Commissioner to the woods at the base of Doi Suthĕp, in search of orchids. Passing through the town, we issued from the Patu Suen-dok on its western side. This gate is named after a pleasure garden of the Chief of Chiengmai, situated about a mile from the walls, which has been allowed to run to waste. As we emerged from the gate, the great mountain, which had hitherto been concealed by trees, appeared close at hand, almost overhanging our heads. The road leads in the direction of a pagoda built half way up the mountain side, and is broad and grassy as far as a small *salâ*, where we branched away to the right across the now dry terraced rice-fields. At the edge of the woods we were met by a hale old man, who is the "governor" of the mountain, accompanied by four or five men carrying baskets to hold the plants we expected to collect. The path ascended over the sparsely wooded spurs, and wound along to a beautifully cool and romantic spot on the banks of a torrent called Huei Mĕ-chang-khien. Here we found a white clematis, *doh niŭ*. Our luck was pretty good, and we succeeded in obtaining a dozen or more varieties of orchids, which seem to prefer trees that are more or less decrepit and decayed. One of these has a pretty white flower, touched with mauve and pink, and giving forth a pleasant fragrance. It is not much admired by the Laos, who have given it the name *dok-üang ki mâ*, which, in English, has such a malodorous sound, that I will leave it untranslated. On our way back we crossed the fields in a different direction, to the north-west angle of the city, and then along the north wall to the river side wall. Some of the fields were being broken up for a winter crop of rice.

One morning we received a summons to the Chief's house to be present at the presentation of the tribute orchids already mentioned. The ceremony took place in the audience-hall. We all sat on chairs, ranged in a semicircle, the Chief wearing his everyday dress. The Lawas from Mu'ang Yoom were introduced by an old Lao, who has served under seven successive chiefs of Chiengmai. They brought with them a tazza full of amaranths, which this old man handed to the Chief, repeating first a long exorcism, during which the Chief held up his hands, as if in prayer. Next, a long joint of bamboo, full of arrow poison, and a few skeins of cotton yarn were offered to him. Then a small stone mortar, full of powdered ginger, was handed to the Chief, who put some in his mouth, chewed it, and spat it out, to symbolise the fertilisation of the ground for the reception f the rice seed. The orchids were there, stuck into two sections of a tree, but apparently no reference was made to them. The whole business was got over very quickly, and was of the simplest possible character. I should mention that, at the end, the Chief lifted up his voice, and delivered himself of a short oration, of which I cannot give the contents, as no one thought it worth translating; but what impressed me most was the informal and "fine-old-English-gentleman, all-of-the-olden-style" manner he assumed. The Chief stuck an orchid through the hole in his left ear lobe, and gave us each a sprig to do likewise, but not being provided with those useful apertures, we had to put them behind our ears, which is, after all, quite as elegant as the native manner of wearing a flower. We then adjourned to a raised shed, to hear some music performed by women on a sort of three-stringed lute, having three frets, which was placed on the floor in front of the player. An ivory pencil is used for striking the strings. The performers were two women, who played in unison, and the music was of simple monotonous character. There were a number of bamboo harmonicons and sets of small gongs lying about the room, which seemed to be of Burmese origin. The native Lao instrument is the bamboo flageolet.

During the whole of my stay in Chiengmai, I constantly longed to ascend Doi Suthĕp, and ascertain its height, but business at first, and afterwards an unseasonable period of three days persistent rain, frustrated my hopes. I managed, however, to get as far as the pagoda, which is approximately 2,200 feet above the city. Leaving the Vice-Consulate one day about a quarter-past nine, I walked my pony through the city, and out by the Patu Suen-dok, reaching the deserted garden by ten. This place is supposed by some of the foreign residents to be the site of an earlier town. But it is much smaller, by ten or twelve times, than the present city, and if it were ever surrounded by a wall, nothing now remains but an earthen mound. Immediately opposite, on the south side of the road, are the remains of a Buddhist temple, standing in a square enclosure, pierced on the north, south, and east sides by arched pyramidal gateways, nineteen feet thick. Inside of this is a smaller enclosure, at the west end of which rises a lofty circular *phra-chedi* on a square base, having a smaller *phra-chedi* at each corner, and a steep flight of laterite steps on each side, at the top of which is an arched gateway. These eight structures on the outer edge of the base have sharp pyramidal pinnacles, while the coping of each flight of steps is formed by a five-headed *naga*. The *wihan*, which fronts towards the east, has four graduated roofs, the highest end being next the *phra-chedi*, its interior consisting of a nave and two aisles. At the west end is a colossal sitting Buddha, some twenty-four feet high, of brick and mortar, freshly gilt. Back to back with the *wihan* stands a small but massively constructed shrine, decorated with stucco ornaments, and containing a small sitting Buddha, apparently quite new. The doorway of this shrine is curious, being a mere longitudinal slit, as it were, in the wall of the building; or, rather, it looks as if the wall, with all its mouldings and other ornamentations, had been divided vertically in the centre and then pulled apart to show the image in the interior. Gateways on this principle, which look as if a small *phra-chedi* had been cut in two, and its parts set up on either side of the passage-way, are, however, not unfrequent.

Between the city and this garden are dotted here and there several tall *phra-chedi*, of which scarcely anything now remains but their brickwork core. Nothing, however, can be inferred as to their having been included within the walls of an earlier city.

A quarter of an hour's ride beyond the *salá*, where we had diverged from the road on a previous occasion, brought me to the foot of the mountain. Here I left the ponies, as the path was too rough for them, and began to ascend the foothills, which are covered with scrubby trees, now almost denuded of their foliage. Further on the path divided, on the right ascending a sunburnt, clayey spur, through sparse forest; the left, following a purling stream through densely-growing umbrageous trees, and over damp, black soil. This contrast would seem to suggest that it is want of moisture, and not cold, that causes most of the trees in the Laos to shed their leaves during the winter. Close to this spot a delicate dwarf bamboo, having stems no thicker than ordinary grass, and reaching a height of about two feet, was pretty abundant. At a height of about 2,100 feet above the sea, acorns were lying in the pathway. They had fallen from large trees with lanceolate leaves of rather thin texture. There was also what I took at first to be the fruit of an oak, but may, perhaps, have been a diminutive chestnut; it was covered with prickles, and most specimens had only one kernel. The shell split naturally into three parts. It is certain, however, to judge from acorns which were afterwards shown to me in Chiengmai, that there are five, if not six, distinct species of oak on Doi Suthĕp. Ten minutes below the summit was a green swampy glade, where a party of men and women were gathering the flower *dok un*, which the latter wear in their hair. To represent the pronunciation of the second syllable to the eye, it should be printed half a letter higher than the first. Such a system of noting the tones of these monosyllabic languages would, if practicable, be far more effectual than the use of accents or other diacritical marks, which are so easy to forget. For in Lao, as well as in Siamese, it makes all the difference in the world whether you pronounce a syllable with a rising or falling inflection of the voice, with a combination of both, or with no inflection at all.

The pagoda stands at the top of a detached knoll, and is approached by a long flight of steps at the back, on either side of which stands a row of lofty pines, evidently planted there, for although the tree can be seen in abundance on the summit of the mountain, there are none growing in the woods which surround this knoll. The leaves are three in a sheath, and the cone is from 2½ to 3 inches long. It is possibly the *Pinus* known in

Burma. On the slopes, *Pardanthus sinensis*, an irid sometimes met with in the neighbourhood of certain mountains in Japan about 1,000 feet above the sea, is common enough.

At 12 o'clock I reached the temple, which stands 3,600 feet above the sea, and 2,200 feet above Chiengmai, according to my calculations. On the south side of the hill there were bushes of a large white bauhinia, which sent forth a delicious fragrance. The plain was almost enveloped in mist at this hour, so that the mountains on its further side were indistinguishable. Down below, the thermometer was probably 85°, while at this elevation it marked only 72°. I sat patiently waiting for my luncheon to arrive, and enjoying the fresh air till a quarter to two, when the pangs of hunger began at last to make themselves felt, and, as there were no signs of the basket's approach, I resolved on descending in search of it. About halfway down I met one of my men slowly toiling up the steep path, and no doubt he would have explained the delay to his own satisfaction, at least, if I could have understood what he said. But all I could make out was, that somebody else was to blame. Just below was the junction of the two paths, so I hastened down, and enjoyed my meal in the cool shade, while the servants hunted for orchids. From this spot it took me half an hour more to the places where the ponies were waiting, and I got back to Chiengmai about the hour that it was expected I should have reached the pagoda.

On the 21st January, after many pros and cons as to the best excursion to be made in the neighbourhood, I started to make the circuit of Doi Suthĕp, if it should be found feasible, with elephants. Dr. Cheek, of the American Mission, the Rev. Mr. Webster, who is a missionary to the Karens, and belongs to the Mission in Burma, and Mr. Archer were my companions. We started on ponies, the baggage being carried on nine or ten elephants, including a few spare ones for riding on in case it should turn out impossible to take the ponies across the ridge at the back of the mountain. Leaving the Patu Suendok about eleven, we struck at once into a track leading across the parched rice fields to the south-west, and in about half an hour's time reached the village of Phông Noi, on a streamlet called the Huei Sai. Beyond this, we crossed undulating stony ground, covered with thin forest, and came down upon the Huei Mĕ-hia. Across the stream rises precipitously a pretty wooded hill, named Doi Kham, on which the sun shone brilliantly, lighting up the scarlet tints of the dead foliage. Following this stream for some distance, we at last began to ascend a long horizontal spur, that runs out from Doi Suthĕp in a southerly direction, descending on the other side to Ban Phông, on the right bank of the Mĕ Thachang, a swiftly flowing rivulet several yards wide and about a foot deep. Siamese and Laos are alike averse from long journeys, and the Chief's people, in conjunction with the king's Commissioner, when settling the itinerary, had fixed upon this place for our first encampment; but as it was only one o'clock when we got to Ban Phông, the more active Western blood rebelled against the arrangement, and we determined to go on a bit further after having our lunch. Besides, the *wat* which was destined for my accommodation was by no means a comfortable building to pass the night in. I forgot to mention that the Chief had lent me his best elephant to ride, besides several others, and had, moreover, sent with me a *Chao*, or prince, to act as chief of the escort, and make things generally comfortable. Dr. Cheek had four of his own elephants, if not more, and we should have made an imposing cavalcade altogether, but for the dislike of the elephant for his cousin the horse, which forced us to travel in two separate bodies. There were, of course, a crowd of followers on foot, besides the cook, servants, grooms, and mahouts.

We left again at half-past three, and followed the bed of the stream for about a mile through a shaded rocky gorge, fording it pretty frequently until we emerged into a flat-bottomed little valley cut up into terraced rice-fields. The scenery here is soft and friendly, and recalls many a bit of Japan; on every side rose steep knolls covered with trees, whose brilliantly red foliage was lighted up by the sun now sinking in the West.

Keeping slightly away to the right, in full view of the long ridge which extends westwards from Doi Suthĕp, we climbed a steep hill, which we supposed to be a spur dividing the side valleys of the great mountain, but, to our great surprise, came down again on the same stream, to ascend once more to the top of a still higher hill on its right bank. Crossing this, we descended once more, and, passing through a tract of forest, found ourselves, at five o'clock, still on the right bank of the stream, where we waited for the ponies to convey us across the muddy ford. The general character of the country hereabouts is that of open cultivated valleys divided from each other

by constrictions of the hills through which the stream has cut its way. After another half-hour's ride, the valley opened out into a huge amphitheatre, with rice-fields rising one above the other, like broad rows of seats, in the centre of which stands the hamlet of Mu'ang Ha. We got here at half-past five, and found the *wihan* of a little *wat* prepared for the occupation of Mr. Archer and myself. Dr. Cheek and Mr. Webster, the latter of whom now caught us up after having been behind all day, pitched their tents on the opposite side of the stream.

Howdahs were taken off, and the elephants turned out to feed, while the natives lighted fires all round to cook their rice and to lie by during the night. I imagine that they mostly slept in the open air, wrapped up in their cotton blankets, and at this season of the year there was probably no danger in their lying on the ground. Height above the sea 1,660 feet. The southern summit of Doi Suthĕp bore E.N.E., so that we had already performed more than a quarter of the circumference, since from the Vice-Consulate it bears W.N.W.½W.

On January 22nd the thermometer at half-past six indicated 56°. We started on foot at half-past eight, and traversing the terraced rice fields quitted the valley at its further end. After crossing a steep hill covered with forest, we again descended to the stream which we had followed all the previous afternoon, and after crossing and re-crossing several times finally left it behind us. Its source is evidently somewhere on the southern flank of Doi Suthĕp. We now climbed a steep ascent over stiff red clay to the top of a knoll, called Doi Nyung, which we reached at twenty past nine. From the rising ground to the right of the path we took bearings of the principal points. The southern summit of Doi Suthĕp bore nearly due east, while the *wat* where we had passed the night lay to the south-east. Beyond it we could see a portion of the Chiengmai plain and of the range of mountains which borders its eastern side. The northern summit of Doi Suthĕp bore east by north. A long pine-clad ridge running towards our left was seen extending like the sharp back of some emaciated animal, from a point about 600 feet below the summit. So clear was the atmosphere that with the naked eye we could easily distinguish the form which is distinctive of the coniferous order. The altitude of this spot was approximately 2,000 feet. It would, perhaps, not be impossible to reach the nearer summit of Doi Suthĕp from here in one day, but the ascent would be long and toilsome, as there is no path, and finding one's way up a mountain side by the mere aid of the compass is no easy task.

We waited for the elephants and ponies to overtake us, and continued our journey at half-past ten. The path lay through undulating forest for three-quarters of an hour, till we reached a small open space that seemed conveniently situated for luncheon. On our right were the spurs which stretch down north-westwards from the mountain, while to our left the country seemed to consist of hills and valleys extending in the direction of a plain that was, however, invisible, and perhaps may exist only in our imagination. We had walked a good deal faster than our baggage animals, and it was more than an hour before they came up. Then we had to lunch and smoke a cigar, so that it was one o'clock before we were again under way. By this time every one of the party had walked quite enough for one day, and we got into our howdahs, the sole merit of which, in my opinion at least, is that they make you so uncomfortable that in a short time you feel going on foot to be less fatiguing.

The track ascended first to a height of 2,150 feet, and then wound for a couple of hours round the deep ravines on the steep flank of a lesser mountain, descending rather rapidly at last to a teak forest, where a party of men were working under Dr. Cheek's Burmese contractor. Probably it would be more exact to say Peguan, but this is a distinction that is seldom observed in Siam, although it is not without its significance. The forest occupied a tract of almost level ground, and the timber that was still standing or lying about, ready to be dragged, was consequently not of first-rate quality. Leaving this valley, we crossed a low ridge, and a few minutes after four o'clock reached the hamlet of Ban Samöng, where we put up, as usual, at the *wat*, but not this time in the *wihan*, as there were some long open sheds outside that promised more light and air than the dark and unventilated church. This village, which lies at about the same altitude as Mu'ang Ha, contains eighty-seven houses, indicating a population of about 500 persons. They belong by descent to a people named Lü, that is to say, to the Shans of Chieng-tung, whence their forefathers were probably transported some few generations ago, after a successful raid made on that place by the Chiengmai Laos. They have by this time

become completely naturalised, the only difference between them and the pure Laos being in their intonation of the language.

The real object of our trip was to visit a teak forest, in order to get an idea, from actual inspection, of the manner in which the timber business is carried on. These forests exist all over the five northern Lao provinces, and many of them are worked by Asiatic British subjects, under contract with the chiefs and other owners, in some cases by lease for a period of years, in others upon annual agreements, the usual terms being a royalty of three or four rupees a log, besides the presents in the nature of a premium that are given in order to obtain a lease. The lessees seldom or hardly ever are men of capital, but obtain funds at a high rate of interest (generally 3 per cent. a month) from the Indian money lenders at Maulmein. A lessee will work part of a forest himself, another part will be sublet, and a third part will be handed over to contractors, who undertake to deliver logs at a fixed price at the bank of the stream by which they are to be floated down. The original lessee is bound to pay the royalty on each log before it leaves the limits of the forest on its way down to Maulmein or Bangkok, and to him the owner is entitled to look for payment. But sometimes he recognizes the sub-lessee by consenting to receive the royalty from him direct. The foresters, being mostly men of straw, as a rule, do not pay the royalty on taking away the timber, and in order to remove it have to give a promissory note for the amount due, with interest again at 3 per cent. a month, and they often assign by way of collateral security some indefinite number of logs still lying in the forest, or so many elephants, which are not in any way identified; this sort of document they are in the habit of styling a mortgage. Everything goes smoothly enough if rain falls annually in sufficient quantity to float out into the rivers the logs which have been dragged into the mountain stream. The forester then sells them at Maulmein or Bangkok, or, perhaps, on the way to either of those places, and having got his money is in a position to redeem the note he has given for the royalty. If he is honest he gets on all right, but many of these men have extravagant habits and prefer spending the cash on women, or temple building, the two kinds of luxury to which the Burman or Peguan is chiefly addicted. He gives fresh notes to the lessor, and the debt continues to grow at compound interest until all hope of its ever being discharged is given up by the parties. Then the owner tries to come down upon the lessee, sub-lessees, and contractors; he lays violent hands upon all the logs lying in the forest and upon all the elephants he can find, no matter whose they are, and in entire disregard of the rights of the men who have by their labour given to the timber nine-tenths of the value which it now possesses. And a pretty crop of lawsuits is the result. Another source of dispute in past times has been the practice indulged in by some of the chiefs of granting away the same forest to two different individuals, or of giving the lease of a forest to one man after he has already accorded to another the right of cutting timber, in spite of a special treaty dating so far back as 1874, by which the Siamese Government undertook to put a stop to these proceedings. In another article of the same treaty it was provided that a court should be established to try all cases between British subjects and Siamese or Laos, but it never heard or decided a single action. A fresh treaty was therefore concluded in 1883 which, as far as can at present be seen, promises to produce better results under the constant supervision of the Vice-Consul, stationed at Chiengmai to look after the interests of the numerous British subjects scattered over the Northern Lao States.

The teak from the western part of Nan, the State of Phrĕ, and from part of Lakhon, comes down the Mĕ Yom past Sawankhalôk, while a certain quantity descends from Eastern Nan and the provinces of Phichai and Phitsanulôk by the Menam Phô. A small quantity of inferior timber is obtained from the provinces of Sawankhalôk and Sukkhothai also. The two rivers unite a short way above Paknamphô, from which place the rafts pass down the Mĕnam. That of Western Lakhon, Northern and Eastern Chiengmai and Lamphun finds its way by the Mĕ Ping to Paknamphô and so to Bangkok. The Siamese provinces of Mu'ang Thön (Tern) and Rahĕng also yield a certain amount. On the west of the State of Chiengmai is the well known forest of Mu'ang Yuom, the produce of which finds its way to Maulmein by the River Salween, as does likewise that of the Thoungyeen Valley, the opposite sides of which belong respectively to Burma and to the Siamese province of Rahĕng. Further north, contributions are received from Mĕhong-son, which belongs to Chiengmai, the valley of the Mĕ Hang, and even from the banks of streams which lie in the western districts of the State of Chiengtung. A curious circumstance is the

great difference in the prices obtained at Maulmein and Bangkok. At the former port the rates for the finest logs are from 80 to 100 rupees, while at the latter they sell for no more than for 35. One explanation I heard offered is that in Maulmein there is a considerable market for shingles cut out of the "slabs" or outsides of the logs, while in Bangkok these are almost of no value, and hence the exporter cannot afford to pay as high a price for the rough logs as the teak buyers of Burma are ready to give. Logs at Chiengmai, on which the royalty of 3 to 4 rupees has been paid, are worth, say, about 15 rupees, and the average cost of transit thence to Bangkok is 8 rupees, half of which is for elephants "ounding" them over shallow places down to the rapids and thence to Rahĕng, where they are made up into rafts, the balance of the 35 rupees representing the cost for rafting to Bangkok. At Chhainat a duty has to be paid to the Siamese Government which averages another 4 rupees. So that with the high interest on the capital embarked in this trade, the profit to the forester is a very uncertain thing. If he is lucky in getting his timber out quickly, he will make money, but if a succession of dry seasons intervenes he loses heavily. Three years is probably the least time in which a log can be cut and brought down. The fluctuations of the market at home, which of late years have been severe, must also be taken into account, and it is almost a matter for surprise that any man should think it worth his while to embark in such a business.

We spent the morning in visiting a teak forest about three miles up the valley. The walk thither was delightful, now alongside the clear fresh stream, now by a path over some projecting bluff, while a brilliant sky, a cool breeze, and the sight of tall pine trees fringing a hill about 300 feet above us, contributed to elate the spirits of the party. After a prolonged sojourn in a tropical country, the mere presence of vegetation which recalls more temperate climes, is in itself a source of joyousness. At last we came to a spot where some 800 massive logs, many of them over 3 feet in diameter and 35 feet in length, were lying densely packed in the narrow bed of the stream, their lower surfaces just wetted by the flowing current. Beyond this was the forest where they had been cut. Some elephants were brought round from the opposite bank where they were engaged in dragging timber, and we saw them harnessed to logs. The gear is made of twisted bark, and is of the roughest description, passing round the animals chest, and attached to the log behind by a chain passed through a hole cut at its thick end. Rough stems of young trees are placed underneath as rollers. The elephant, on being started by the mahout, moves forward during a few moments at what is a great pace for him, and then stops for an equal space to take breath, for the clumsy band across his chest impedes respiration, so that continuous effort is impossible. When urged forward again, he utters loud cries of indignation, but with a great effort soon renders obedience to the voice of his driver. In the forest of Ban Huei Samöng the teak trees are mostly near the stream, but in some parts of the Lao States the timber has to be dragged as much as ten miles, and the labour required to get it to the bank of the stream is enormously expensive. The elephant seems to do little work in proportion to his huge size; for three days he drags timber up to noon, and then has a five days rest.

The logs are felled during the rainy season, when they are less likely to be split by the fall, as the ground is then soft. One forester cuts a single log per diem, but three usually work together, and cut the same number of logs. They use a heavy long-handled axe, in preference to a saw. We saw several fine trees lying there which had been utterly ruined by splitting, for ropes are not employed to break the force of impact on the earth. The woodmen, no doubt, try to direct the fall of the tree so that it may come down clear of its neighbours, but they are not always successful, and then the trunk comes crashing down through the surrounding branches, damaging itself and sometimes seriously injuring the men who have miscalculated the effect of their blows. Before being felled, the trees are "girdled," that is to say, the bark is roughly hacked through with the axe at a height of about four feet from the ground, so that the tree dies, after which it is usually left standing for three years to dry. But sometimes the lessee has a larger number of trees "girdled" than he can cut during the term of his agreement, and they may then be left to dry for several years, which much impairs their value. A custom appears to exist of allowing the outgoing lessee to exact from his successor a rupee for each tree "girdled" and left standing. This right should not be recognised by the courts, as it leads to waste, and the price thus paid for "girdling" is far in excess of its value. There is no written law to regulate

this industry, and the judges have therefore the opportunity, by carefully considered decisions, of giving the stamp of legality to those forest customs which common sense approves, while refusing to recognise those which are detrimental to the public interest.

There are, of course, no laws or customs having the conservation of the forests for their object, and in a few years more all the timber that is worth cutting will have been exhausted. The teak tree is self-sown, and if the forests are allowed to lie fallow for twenty years or so, the business will again revive. A regulation has been proposed by which the foresters would be heavily fined for each log felled that is of less than a certain diameter, but regulations are of little use when the officials cannot be trusted to enforce them. The unpopular system of government reserves which exists in Burma would be even more difficult of application here.

On the morning of January 24th, about six o'clock, the thermometer marked 50°, an increase of 3° over the temperature of the preceding day at the same hour.

We left Ban Huei Samöng on elephants at about eight o'clock, and taking a path through the village to the right of that which leads to the teak forest we visited the previous day, were soon engaged in the narrow bed of a mountain torrent. Here for the first time I saw an elephant refuse a bank which his mahout ordered him to ascend. Although the track, steep as it was, had been passed by nearly all the other animals, mine could not be by any means be induced to take it, and I had therefore to go round by a longer but easier way. When the path at last quitted the gully we found ourselves on some steep hills, which we crossed into the valley of another small tributary of the Huei Samöng, and continuing to mount upwards, we reached, after travelling an hour and a half, a small clearing laid out in rice fields by a colony of Lü from Ban Samöng. We asked a middle-aged man when his forefathers first came to these parts, and received in answer the information that his parents had migrated from Chieng-tung into Chiengmai territory about twenty years ago, before he was born, displaying thus the utter disregard of dates which is characteristic of people who keep no records. According to his data, his age would be little more than eighteen, although he must have been at least forty-five years old. He said he knew nothing of the Lü language. The rice-fields which lay in the immediate neighbourhood of the cottages had just been prepared for sowing, and the soil seemed a rich black loam. Under a shed some of the women were engaged in weaving white cotton cloth in a loom which consisted of little more than four posts held together by a slight framework. The people here wear a sandal of thin bamboo strips plaited together, and it is worthy of notice that it is held on by a thong passing between the big toe and the next, exactly in the same manner as the foot-gear of the Japanese. I cannot help suspecting that this contrivance is of Chinese origin. The Lao name for this sandal is *kôp*. The position of this tiny isolated clearing, so far above the village, was extremely picturesque. Steep, densely-wooded hills surrounded it on every side, except at the narrow pass by which we had ascended, and seemed to shut it off from the outer world. Lower down we had passed one of the deserted clearings of the Karens. These people, who, in Siam at least, live together in small communities, have no settled villages. They constantly move about amongst the hills, and cut down the forests to plant their crops, migrating to some fresh site after a year or two, which time suffices, it would seem, to exhaust the capabilities of the soil. Height above the sea, about 1,600 feet.

After waiting here half an hour for the elephants, we proceeded on foot up a deep shaded dell, now by the side of the stream, now above it, along its bed, and crossing it frequently. I could have easily imagined myself in some remote part of the mountain districts of Japan. In forty minutes Mr. Webster and myself, who, though not entitled to claim rank as pedestrians, went better afoot than the rest of the party, had reached the last spot where water was attainable. The height here was 2,500. Another half hour's toil brought us to the summit of the pass. Just below grew at least two species of oak, and a tall lily, bearing large ripe berries. A knoll on the right seemed to invite us to climb a little further, and, in ten minutes more, we were rewarded by a magnificent view of mountains on every side, and of Doi Suthĕp, rising high above us, about E.S.E. But deep intervening densely-wooded ravines forbade any attempt to reach it. South-west, in the direction of Mu'ang Yuom, we saw the great mountain that is also visible from Chiengmai. Far away below us, almost due west, we perceived the rice fields of Ban Huei Samöng, while, through a gap on the opposite side, we could discern other fields in the Chiengmai plain, which the

guides seemed to think must lie near Ban Katsá, the hamlet we were to reach on the following day. The ridge we had attained was covered with tall pines, and a kind of dwarf palm was common on its steep, almost precipitous sides. It was just the spot for a picnic. A guide was sent back to stop the elephant which carried our lunch; and we waited there, enjoying the view, and otherwise idling the time away, till half-past one, when the beast at last appeared. This will give an idea of the slow rate at which elephants climb, as compared with a man on foot. Neither Mr. Webster nor myself were in proper training: he had only just recovered from a somewhat severe attack of malarial fever, and I had injured a knee by too much tennis. We had, however, taken only an hour and ten minutes to make the ascent which had occupied the elephant three hours.

My Japanese servant, who carried the aneroid, had unfortunately gone on, not knowing that we were on the knoll, and therefore I was unable to determine the height, but we may fairly add a thousand feet for the half hour's climbing, which would give 3,500 feet above the sea for the top of the pass.

We quitted this delightful spot at a quarter to three. The path at first winds round the top of a pine-clad spur stretching towards Doi Suthĕp, and then plunges down a declivity in a north-east direction, bringing us to the hamlet of Pong-yeng. Just at the bottom of the hill we passed a plantation of *mieng*, or Lao tea. The natives call these plantations *pa-mieng*, or tea-forest, if *pa* be rendered literally, this term causing it to be generally supposed that the *mieng* grows wild. Laos tell you that it is found growing in commixture with other trees, which are cut down, leaving the tea-tree to benefit by the additional air and sun. But this account seems doubtful. It is possible that the Laos of Chiengmai, when the country was resettled, found old tea-trees growing in this way, and cleared them from the jungle which enveloped them, but the arrangement of the trees is too regular to allow of our supposing that they were planted by the mere hand of nature. Many were twelve to fifteen feet high, with stems two-and-a-half to three inches in diameter, and they were evidently not pruned. Some were in bud or flower, and others bore the half-ripe berry. The leaf is longer and more pointed than that of the Japanese tea-plant, and the foliage is less dense, But of its being a species of tea there can be no doubt whatever. The Laos do not drink the infusion, but prepare the leaf for chewing by burying it in pits, and it is one of their indispensable luxuries. You see a man put a lump of the fermented leaves in one cheek, which he leaves there while he proceeds to chew betel or smoke a cigarette, looking for all the world as if his face were distorted by the mumps.

The village of Pong-yeng is situated in an extensive amphitheatre surrounded by hills, and having for its area a series of terraced rice-fields rising from the centre. Here three brooks unite to form the Mĕ Sa. Northwards, above the nearer hills, rises Doi Kwamlong, where a hero of local legend lies buried below a precipitous rock near the summit. He is said to have determined the site of Lamphun by shooting an arrow from the top of Doi Suthĕp, and on the spot where it fell the city was founded. He must have used a very long bow on this occasion, since the distance is about twelve miles as the crow flies. He afterwards removed his abode to a place on the west bank of the Salween and died there. His corpse was brought home to be buried either at Chiengmai or Lamphun, I forget which, but arriving at Pong-yeng, could not be got to pass the spot where it now lies, and the spot which is pointed out to you from Pong-yeng is "alive to this day to testify of it."

As usual, we put up at the village temple, and passed the evening sitting round a wood fire, smoking and drinking whiskey punch by moonlight, while the doctor, who speaks Lao like a native, entertained some of the guides and ourselves with an interchange of marvellous sporting stories of rare animals and fish bigger than whales that are believed to haunt the waters of the Mĕ Khong. The Laos take care to place the locality of these wonders as far away as their geographical knowledge permits, and if you doubt what they say, you can go there and see for yourself.

On January 25 the barometer showed the height of Pong-yeng to be about 2,000 feet above the sea, while the thermometer, at sunrise, marked the same as the previous morning, namely, 50°. We started at a quarter-past eight, and crossed the rice-fields to the point where the Mĕ Sa makes its exit through a narrow gorge. Here, in a shady spot, is a good-sized tea plantation. A little further on we were requested by the *chao* to dismount from our elephants, as we were approaching a dangerous precipice high above the left bank of the stream, where there was a possibility of

falling over. But the peril was much exaggerated, and the animals passed safely along. In fact, there was no danger at all, but if anything had happened, the *chao* would have been rendered responsible on his return to Chiengmai, and he did not like to run the risk of having his head taken off for allowing even the little finger of a "distinguished foreigner" to get scratched. It was a pleasant walk, continually descending by a rocky path, and generally in sight of the roaring torrent. We rested half-an-hour at a romantic spot where a fallen trunk formed a natural bridge, near a pool that filled us with regret at not having our towels with us. Shortly afterwards we forded the stream, which, having now descended to the level of the plain, was taking its ease under overhanging branches. Then we climbed again up a hillside, and, descending a second time, entered a teak-forest, where the direct path to Chiengmai seemed to diverge to the right among the trees. We were in no hurry to get back there, and so kept on our way to Ban Katsa. Mr. Webster and I were in advance, the others having returned to the discomfort of their howdahs. By twenty minutes to twelve we reached the edge of the cultivated plain, and lay down under a tree to wait for our companions, who came up just an hour later.

From here it was ten minutes' walk across the rice-fields to the village. Here the *chao* wanted to lodge me in the *wat*, but as there was a stream not far off, it seemed better to migrate to its banks and pitch our tents among the trees. A capital spot was found in a grove, and while we made ourselves comfortable in the shade, the Lao guides busied themselves with the construction of a bamboo bathing house out in the stream, so that we could enjoy a bath in the clear, cool, running water.

During the evening an alarm was raised in the camp by news of an elephant in "must," that was supposed to be about to make a rush upon us. When the male is in this state he is usually isolated, and the elephant in question, which belonged to the Chief, had been sent out to the neighbouring jungle to be kept quiet until the fit was over. Somehow or other he had got wind of our party, and was reported to be coming down. His mahout was not to be found. Our *chao*, who is the Chief's principal keeper of the elephants, had a double source of anxiety. If the infuriated beast were to charge the camp, one of us might be trodden under foot and killed; and it was possible that a fight would occur between the elephant and some of our animals, which would be equally productive of disaster to them. He begged earnestly that we would go back to the *wat* and place ourselves in safety within its walls. I consulted Luang Suriya, who was of the party, and found him by no means alarmed; he thought that it would be rather good fun if the elephant did make his appearance. My other companions were of the same opinion, and we united in resolving to run the risk. In the meantime a number of men crossed the stream with torches to drive the elephant back in case he should really attempt to get near our animals, while others went in search of the mahout, whom they luckily found at last. Tranquillity was therefore restored, and we congratulated ourselves in having stood firm. In such a matter a foreigner is bound almost to be guided by what a native, speaking with authority, tells him, and if the *chao* had been alone probably I should have taken his advice, but as Luang Suriya hinted pretty clearly that the *chao's* warning proceeded from the excessive caution of which an example had already been given during the morning, we were justified in disregarding it and in consulting our own inclinations.

We were now some ten or twelve miles from Chiengmai, and as ponies had been sent out by Mr. Gould to meet us, the doctor and Mr. Archer rode gaily in on the following morning. Mr. Webster, who felt his walking powers were completely restored, preferred to proceed on foot. Having hurt my side by falling over a log a couple of days before, I had to have recourse to my elephant, and, as it was a level road, and the mahout probably was willing to get home as quickly as possible, he urged the animal to its utmost speed, so that we actually covered the distance in three hours and a half. This, you will perceive, gives him a maximum rate of 2·857 or 3·428 miles an hour, according as you take the lesser or greater estimate of the distance; and he is one of the largest elephants owned by the Chief. Slow and steady should therefore be the motto of the traveller by this kind of conveyance.

My visit to Chiengmai terminated soon after this excursion. After somewhat vexatious delays, I started for Bangkok on the 10th February. With the exception of the first three days, the whole of the journey was spent on the Mĕnam River. The distance from Chiengmai to Bangkok has been accomplished in nine days; not, it is true, without risk in

descending the rapids, and travelling part of the way at least by night. But it all depends upon the depth of the water. It took me four weeks—from the 10th February to the 10th March—and as the river continues to fall until the beginning of May, the journey must frequently extend to even a longer time. The distance is about 300 miles, as the crow flies, and is probably not more than 450 miles, when a liberal allowance is made for the windings of its course.

DISCUSSION.

Mr. HOLT S. HALLETT said this paper had been of great interest to him, as it recalled to him scenes previously visited by him in the neighbourhood, although a portion of the ground covered by Mr. Satow was quite new to him. Tea was found in various places throughout the range of hills lying to the west of Chiengmai, from Rahëng, all the way up to China. As soon as he crossed the range from Burma into Siam, his mahout brought him branches of the tea plant, which he found was about 15 or 20 feet high. Unluckily, he did not take notice of the distance the plants were apart, or if they were regularly set out; but it was very interesting to hear that these tea plants on Doi Su-thëp had been regularly planted at some time or other. Similar hot springs to those mentioned by Mr. Satow were found throughout the whole of the region, at different places amongst the hills. He came across one in the bed of the River Meping, up above Chiengmai, and another one in the bed of the Melow; but wherever he went he heard of their existence; and, from the aspect of the country, it was evident that at one time it had been subject to great earth movements, and even at present earthquakes were not unknown. The people called Lu, whom Mr. Satow met with at two or three places on his journey, were inhabitants of the State of Chieng Hung, otherwise known as Kiang Hung. Through distubances at various times they had been scattered. Dr. Neis met with many of their villages in 1883, in the lower valley of the Me U. They were also found in other places between the Mekong and Chiengmai. The *repoussé* work which Mr. Satow saw in Chiengmai was carried out exactly as he had been informed: resin was put inside a plain silver cup, and it was then hammered into shape with a tool. He understood that the Lawas, who carried tribute to the Chief of Chiengmai, were under the State of Lamphun, not under Chiengmai, but that Lamphun itself was more or less under Chiengmai; and it was interesting, therefore, to learn that there was a tribute paid by the Lawas direct to Chiengmai. Chiengmai was still independent; but, since he was there, the King of Siam had been gradually endeavouring to turn it into a province. He had heard that the heavy taxation raised in Chiengmai in recent years had caused two insurrections, and that Siamese taxes were now levied there, in addition to the taxes levied by the Shan chiefs. With regard to the rate at which elephants travelled, he might say, as the result of very extensive journeys by elephant in that country, that the ordinary rate on fairly level ground was two miles an hour; but there were some especially rapid elephants which, on a good road, would walk faster than a man.

Mr. R. L. MORANT said it might interest people to know, in view of the shortcomings with regard to Government regulations, especially for forestry, to which Mr. Satow had referred, that centralisation, which was one of the great steps of progress in civilisation, was already making itself felt under the wise and enlightened Government of the present monarch of Siam, and that now the whole country was being divided into large provinces, over each of which there was a Royal Commissioner sent direct from Bangkok, with full powers given him from the Government. This arrangement of course would rapidly and surely remove many of the shortcomings referred to, as this Commissioner was specially sent to see that arrangements were made for the improvement of traffic and communication, and for smoothing over those difficult questions with regard to lawsuits which, as Mr. Satow had said, formed one of the great pleasures of the people, and at the same time one of the great obstacles to the increase of commerce. The poor elephant had come off rather badly in Mr. Satow's stories, but it must be remembered that if he was slow he could go through almost any country, in fact, through a country where few if any other animals could go, and he was, therefore, a very valuable beast of travel.

Mr. C. M. KENNEDY, C.B., desired, as a member of the Council of the Society, to express their thanks to Mr. Satow for this most interesting paper, which was a new contribution to the contents of the *Journal*. It was valuable as affording information with regard to a country little known, and papers of this kind were particularly useful when they gave trustworthy accounts of those little known regions in South-Eastern Asia. He might add a few remarks with respect to Siam. The trade is chiefly in British hands served from the colonies of Singapore and Hong Kong. The country is rich in minerals: it contains tin and gold, and likewise ruby and sapphire mines. There are no actual statistics to show the value of the trade, but that at Bangkok might be estimated at about £4,000,000 a year, and is therefore well worth cultivating, as the tariff is moderate, and there are opportunities for considerable extension. In late years good regulations have been adopted to check the sale of spirits by Chinese dealers, which was beginning to be a very serious evil in Siam. Looking to the future, it must be expected that new routes will be opened across Siam from the Malay Peninsula to the China Sea, which will open out the country, and be of use in shorten-

ing by several days the communication between Europe and the Far East. Further information respecting Siam may be found in two recent publications of the Foreign-office, viz., Nos. 771 and 938 of the series of annual reports.

The CHAIRMAN, in proposing a vote of thanks, said that Mr. Satow's chief claim to their attention was that he had represented the British Government in Siam for four years. Of the country itself, he might observe that it occupied a position of particular eminence in a category of States which was now becoming extinct—the tributaries of China. When English relations with China began, fifty years ago, China had tributary to it—beginning at its north-east corner—Corea, and at the south-west, Burmah, Siam, Annam, and Lewchew. Japan might be said to have absorbed Lewchew. Corea had passed into such a position that, although she made perhaps a nominal tender of tribute, her old relation to China was either annihilated, or about to be. Burmah had been absorbed by England, Annam by the French, to all intents and purposes. Siam, which was let alone by the foreign powers, took the almost unexampled step of deliberately withdrawing, little State as she was as compared to China, from her position of tributary, and had, within the last fifteen years, formally signified to China that she was an independent State. A very great compliment was due to Siam for her original advance, for it was almost entirely original, into civilisation. She had taken precedence of all those nations that surrounded China in the manifestation of her desire to adopt European civilisation as the one means of preserving her independence and developing her own powers. Still it was impossible to regard her position without a good deal of apprehension, quickened by the sympathy that it was impossible not to feel with her for the reasons he had stated. She was a small power which certainly could not extend her boundaries; she was alongside the protectorate of a great power which was certainly manifesting an intention, if not to absorb her, at all events to encroach on her limits; and she had, within herself, nothing to bear up against difficulties so tremendous. From the paper just read, it was evident that there was some slight danger of a difficulty at home, viz., that the means which civilisation would apply to the development of her resources, and to the maintenance of those means she still possessed, would hardly develop themselves with sufficient rapidity; and he could not contemplate the condition of the Laos without certain misgivings that they must be destined to disappear; and that, too, probably for want of greater readiness to adopt such resources as were relied on in India, the teak forests—now solely worked by them—would share the fate of the camphor forests in Formosa.

The vote of thanks having been unanimously passed,

Mr. SATOW, in acknowledging the compliment, said the paper might be somewhat dull, but that arose from the fact that it was simply a plain narrative of what had occurred; and there had been no attempt to dress up any incidents, so as to give them a picturesque or romantic character.

Miscellaneous.

MOSCOW ELECTRICAL EXHIBITION.

Information respecting an Electrical Exhibition, to be held at Moscow in the course of the present year, under the superintendence of the Moscow Section of the Imperial Russian Technical Society, has been received from the Foreign-office through the Science and Art Department. The Russian ambassador has communicated to the Marquis of Salisbury the invitation to exhibit of his Government, addressed to those interested in Electricity. The Exhibition will consist of the following groups:—

1. Electric light; Transmission of force.
2. Telegraphy and Telephony.
3. Electro-technology (Electro-Metallurgy, Electrolysis, the Galvanoplastic art, &c.); Electricity as applied in the railway service, the marine, the military science, in medicine, domestic economy, &c.
4. Electric Piles; Condensers; Static Machines; Thermo-Electric Batteries; Magneto and Dynamo Electric Machines; Transformers; Electro-Motors.
5. Motive power; various boilers; Motors used in Electro-Technics.
6. Measuring and precision instruments; scientific apparatus.
7. Novelties in whatever branch of industry.
8. Literature, plans, designs, diagrams, &c., referring to Electricity.

The Exhibition will be opened on the 14th April, and closed on the 14th October. Applications for space are now being received.

Foreign products destined for the Exhibition are imported Custom-free into Russia, provided they be sent back within a month after the close of the Exhibition, or in case of their being offered as gifts to the Imperial Russian Technical Society. The Custom-house charges must be paid when the exhibits are being sold at the Exhibition.

The gifts offered by exhibitors to the Moscow Section of the Imperial Russian Technical Society will serve to form a museum or an electro-technical laboratory.

Correspondence.

SERICULTURE IN ASIA MINOR.

In May, 1885, the writer was enabled, from personal observation on the spot, to report upon the silk

harvest of Bournabat, near Smyrna, Asia Minor, which report was printed in the *Journal* (vol. xxxiii., p. 852). The sericultural industry was then in a state of slow revival from a condition of almost utter collapse, caused by the deadly effects of the various silkworm diseases which had long devastated, and nearly ruined, the "magnaneries" of France and Italy. Subsequently, in 1887, in an extended and illustrated form, the report was reproduced, with additional sericultural and other information, in the volume entitled "Pen and Pencil in Asia Minor," published by Sampson Low & Co. On both these occasions the writer endeavoured to interest the public in the story of an effort, on the part of an English gentleman, to benefit the Turkish peasantry and revenue of the country, which had more of the romantic element in it than is usually to be found in ordinary industrial operations. For nearly half a century, Mr. John Griffitt, of Bournabat, a village near Smyrna, has devoted most of his leisure hours, well seconded by his accomplished Greek wife, to combatting the maladies of silkworms, experimenting with the various known races, and endeavouring to improve the quantity and quality of their silken produce. Long before M. Pasteur, the distinguished French physiologist, took the field, Mr. Griffitt had been working at the same problems, the solution of which brought the great Frenchman afterwards so much well-deserved honour; but while the one was rewarded, the other has hitherto been neglected. The first enjoyed the wealth and influence of his Government to encourage him in all his efforts; the second has had to struggle on unaided throughout his long career of philanthropic endeavour against the inertia of sluggish or hostile officials, the childishness of a prejudiced peasantry, and a horde of unscrupulous native and foreign parasites, ever ready to appropriate his methods without acknowledgment, to claim or dispute his discoveries, and to defraud him in every possible way. From the first, Mr. Griffitt welcomed and applauded the remarkable results of M. Pasteur's investigations, and became his acknowledged disciple; but, being himself a practical silk-farmer, which M. Pasteur was not, was soon in a position to shoot ahead of his master, to modify, supplement, and stamp with his own genius many of the suggestions of the great chemist, for which he never received either credit or reward. Probably in no other country in the world, except Turkey, could a native, or even a foreigner, accomplishing the revival of a staple industry as Mr. Griffitt has done, have escaped recognition, or being loaded with honours. He has rescued sericulture, upon which so many thousands, perhaps millions, depend in Turkey, from extinction, and been a means of replenishing the usually collapsed Ottoman exchequer, and enabling the Porte to offer British bond-holders—if it chooses to do so—substantial dividends, instead of mere polite excuses.

Still more recently the writer had a paper in the *Journal* of 23rd August, 1889 (vol. xxxvii., p. 772), when further information was given regarding Mr. Griffitt's continued successes, particularly in open-air sericulture. On the present occasion, he would add the latest facts, which are quite as interesting as those already communicated.

At the beginning of 1891 a report by the "Chambre des Deputés" was presented to the French Government, in which it was said that sericulture was not progressing in France in consequence of the re-appearance of the dreaded disease known as "flacherie," along with some minor maladies, and that the nurseries were being decimated. M. Pasteur's discoveries had enabled the silk-farmers to vanquish the other distemper "pebrine," but "flacherie" was working havoc everywhere, so a grant of several millions of francs was asked to be expended in trying to crush the disorder.

Meanwhile, Mr. John Griffitt, with no Government money or help of any kind, had thoughtfully built up a system of scientific silk farming at Bournabat, near Smyrna, in which he combined the most notable of M. Pasteur's discoveries with the invigorating method of M. Roland, of Switzerland, and his own experiences, with the result that his worms acquired such robustness that he had had no deaths among them for years, while all the races, subjected to the process, yielded a larger crop of better silk than before. So marked was this improvement that a comparison will show it at a glance. In the first report already alluded to, made in 1885, Mr. Griffitt's yield of cocoons—considered a splendid return at the time—was 78 kilogrammes (171 lb. avoird.) per ounce of eggs set to hatch, while in 1890 the harvest was 91 kilos. (200 lb.) per ounce of eggs. These figures have been vouched for by M. E. Charmand, chief of the Smyrna branch of the "Direction Générale de l'Administration de la Dette Publique Ottomane, à Constantinople," who reported his observations, gathered from time to time in Mr. Griffitt's factory at Bournabat, to his superiors at the Turkish capital.

Following up these efforts, and stimulated by the ill-success of the French sericulturists, Mr. Griffitt last year achieved an additional triumph, his latest crop showing an advance to 92 kilos. (202 lb.) of cocoons per ounce of eggs. This harvest had likewise been watched through all its stages, and reported upon to the Constantinople authorities by the same gentleman already named, who added that as the yield from foreign eggs had been *nil* at Bournabat, their importation into Turkey ought to be stopped.

It will be evident to the readers of the above and former communications that Mr. John Griffitt's single-handed and almost phenomenal success in sericulture, in the face of the utter failure of the best silk-farmers of France, point to Bournabat as the future sericultural school of the world, and as the *entrepôt* for robust graine. If further figures be required, they are to be found in the circumstance that during the last four or five years the finest French eggs hatched at Bournabat have only yielded

from 10 to 12 kilos. (22 to 26 lb.) of cocoons per ounce, as compared with Mr. Griffitt's 92 kilos. (202 lb.) per ounce of eggs; while last season, according to M. Charmand, the French eggs laid out at Bournabat did not hatch at all.

In a word, if this industry is an important financial consideration to Mr. Griffitt, it can be no less so to the Turkish Government; and the British bond holder of the Turkish debt ought to have every inducement in stirring up the sluggish officials of Constantinople to encourage and befriend a gentleman who is now, and has been so long, working for all their interests.

WILLIAM COCHRAN.

Overdale, Dunblane, Perthshire.

General Notes.

GERMANY AT THE CHICAGO EXHIBITION.—The Berlin correspondent of the *Standard* states that the Reichstag has discussed the proposed grant of 900,000 marks (£45,000 sterling), to assist German industry at the Chicago Exhibition. Almost all the members who spoke were in favour of the grant, as the object of it was to demonstrate to Americans, Eastern Asiatics, and Australians what German manufacturers can do, and thereby to increase, or at least maintain, Germany's export trade. The spokesman of the Government pointed out, that for German industry to remain reserved, would, in view of the strong competition of the Americans, be highly injudicious. It would be very disadvantageous for Germany to sulk in a corner. The only opposition to the grant came from the Protectionist iron manufacturer, Baron Stumm, but his opposition was in vain.

JAPAN AT THE CHICAGO EXHIBITION.—The Chicago *Inter-Ocean* states that the Japaneses Parliament has appropriated 631,000 yen (£125,000) for the purpose of placing the Japanese exhibit at the Chicago Exposition. This indorsement of Parliament has enabled the Government to map out the Japanese exhibit on the lines proposed, and has given confidence to future endeavours. The preparations for the exhibit have been very elaborate, and include the exhibition of the customs, habits, shops, and bazaars of the people. The Press, the officials, and others interested have kept the Exposition well before the people, and future exhibitors have been and are very active. The general result in the passage of the appropriation Bill for the Chicago Exposition meets with universal favour. The Japanese Press is enthusiastic, and the industrial and arts' societies are well pleased. The Bill, as passed by Parliament, anthorises the Government to expend the aggregate sum of 630,765 yen, covering a period of four years as follows:—1891, the sum of 51,495 yen; 1892, 313,098 yen; 1893, 241,536 yen; 1894, 24,635 yen. The expenditures of 1891 are for preliminary organisation, and that of 1892 for the preparation of exhibits; that of 1893 will be devoted largely to transportation, and that of 1894 is to be devoted to closing up affairs.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 27.—F. W. EDRIDGE-GREEN, M.D., "The Scientific Value of Lovibond's Tintometer." R. BRUDENELL CARTER, F.R.C.S., will preside.

FEBRUARY 3.—T. PRIDGIN TEALE, "Dust, and How to Shut it Out." Dr. T. E. THORPE, F.R.S., will preside.

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

FEBRUARY 17.—Capt. F. E. YOUNGHUSBAND, "The Pamirs."

FEBRUARY 24.—Mr. ERNEST HART, "Ancient and Modern Art Pottery of Japan."

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

Papers, the dates of reading of which are not yet fixed:—

"Iceland." By TEMPEST ANDERSON, M.D.

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Durability of Pigments Ground in Oil and other Vehicles." By A. P. LAURIE, M.A.

"Manufacture and Industrial Application of Flexible Tubing." By GILBERT R. REDGRAVE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

FEBRUARY 16—LEWIS ATKINSON, "The Forthcoming Exhibition at Kimberley." 8 p.m. The paper will be illustrated by lantern slides.

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru." 8 p.m.

APRIL 5.—The Rev. JOHN MCLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES

MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19. — JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 26.—WILLIAM MORRIS, M.A., "The Woodcuts of Gothic Books." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., will preside. The paper will be illustrated by lantern slides.

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets."

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

LECTURE I.—JANUARY 25.—Low pressure supply—Comparison between 1885 and 1892—Central stations *versus* isolated plants—Electricity *versus* gas—Cost of feeders and distributing mains—Management of feeders—Use of recording apparatus—House wiring—Three-wire system—Five wires—Use of motor-dynamos as compensators—Batteries—Conductors.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. George Forbes, "Developments of Electrical Distribution." (Lecture I.)

Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. 1. Mr. Wm. Bruce, "Improvements in Cement and Concrete Testing Apparatus." 2. Professor Blyth, "The Application of Wind Power to the Generating of Current Electricity."

British Architects, 9, Conduit-street, W., 8 p.m. Presidential Address to Students.

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arnold Mitchell, "The Vaulted Roofs of the Middle Ages."

TUESDAY, JAN. 26 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. William Morris, "The Woodcuts of Gothic Books."

Society of Architects, St. James's-hall, Piccadilly, W., 8 p.m. Professor J. Logan Lobley, "Building Stones; their Structure and Origin."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Victor Horsley, "The Brain." (Lecture II.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Wilfrid Airy's paper, "Weighing-Machines." 9 p.m. Reception by the President and Council.

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Annual General Meeting. 2. Rev. Dr. John McLean, "The Blackfoot Indian Confederacy with adjacent Tribes at the Rocky Mountains."

WEDNESDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. W. Edridge-Green, "The Scientific Value of Lovibond's Tintometer."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Annual Meeting. 2. Address by the President (Mr. Baldwin Latham), "Evaporation and Condensation."

Patent Agents, 55, Chancery-lane, W.C., 7½ p.m. 1. Discussion on Mr. Abel's and Mr. Loubier's papers. 2. Mr. A. V. Newton, "Patent Agency: its Origin and Uses." 3. Mr. G. B. Ellis, "Compulsory Licenses."

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President, Mr. F. D. Godman.

Royal Society of Literatnre, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, JAN. 28...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circns, E.C., 6 p.m. Mr. E. B. Poulton, "The Methods by which Animals Conceal themselves."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. S. Murray, "Some Aspects of Greek Sculpture in Relief." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Prof. W. E. Ayrton.

FRIDAY, JAN. 29...United Service Institution, Whitehall-yard, 3 p.m. Rear-Admiral Samuel Long, "An Attempt to Estimate the Probable Effect of the Introduction of Quick Firing Guns on Naval Tactics and Construction."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir George Douglas, "Tales of the Scottish Peasantry."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) 1. Mr. William H. D. Cleminson, "The Evolution of Rotating Projectiles." 2. Mr. D. Carnegie, "The Manufacture of Forged Steel Projectiles."

SATURDAY, JAN. 30 ... Frœbel Society, at the HOUSE OF THE SOCIETY OF ARTS, 2½ p.m.

Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Capt. W. de W. Abney, "The Action of Light on Pigments."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Fleming, "The Induction Coil and Alternate Current Transformer." (Lecture II.)

Journal of the Society of Arts.

No. 2,045. Vol. XL.

FRIDAY, JANUARY 29, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

HOWARD LECTURES.

Owing to the illness of Prof. W. C. Unwin, F.R.S., who is laid up with the influenza, the delivery of the course of lectures on "The Development and Transmission of Power from Central Stations," announced for February 5, 12, 19, 26, and March 4, 11, will be postponed.

CANTOR LECTURES.

Prof. George Forbes, F.R.S., delivered the first lecture of his course, on "Developments of Electrical Distribution," on Monday evening, 25th inst. The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

ELECTRICITY COMMITTEE.

The first meeting of this Committee was held on Tuesday afternoon, 26th inst. Present: W. H. Preece, F.R.S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Colonel R. T. Armstrong, C.B., R.E., R. E. B. Crompton, Prof. James Dewar, M.A., F.R.S., Major-General E. R. Festing, F.R.S., Prof. George Forbes, M.A., F.R.S., Prof. G. Carey Foster, F.R.S., Edward Graves, Prof. D. E. Hughes, F.R.S., Gisbert Kapp, J. C. Lamb, C.M.G., W. M. Mordey, J. Fletcher Moulton, M.A., Q.C., F.R.S., Prof. John Perry, D.Sc., F.R.S., Alexander Siemens, Prof. Silvanus P. Thompson, D.Sc., F.R.S., with Sir Henry Trueman Wood, Secretary of the Royal Commission.

DEPARTMENT OF AGRICULTURE.

The following correspondence respecting the Cereal Exhibits has been forwarded to the Secretary of the Royal Commission :—

World's Columbian Exposition,
Department of Foreign Affairs,
Chicago,
January 11th, 1892.

To Sir Henry Trueman Wood,
Royal British Commisson,
London.

Sir,—I have the honour to transmit for your consideration a letter from the Chief of Department of Agriculture in regard to the character and importance of the cereal exhibits at the Exposition, which it is to be hoped will comprehend products of all the nations participating.

We hope to have your highly esteemed co-operation in this matter, and will take great pleasure in receiving any communication upon the subject which you may desire to make.

I am, sir,
Your most obedient servant,
(Signed) Walker Fearn.
Chief, Department Foreign Affairs.

Office of the Director-General,
World's Columbian Exposition,
Chicago, Ill., U.S.A.,
January 9th, 1892.

Hon. Walker Fearn,
Chief, Department of Foreign Affairs,
World's Columbian Exposition.

Dear Sir,—I have the honour to request that you call the attention of representatives of Governments who have accepted the invitation of this Government to participate in the Exposition to the character and importance of the cereal exhibit contemplated, and being arranged by this Department for the Exposition.

In order that the official classification relating to "cereals, grasses, and forage plants" may be comprehended, I beg to quote from said classification the classes comprising the same, as follows :—

Class 1. Wheat and its culture. Varieties of wheat grown in America and abroad; statistics of products and of prices.

Class 2. Indian corn—all varieties. Illustrations of methods of planting, tilling, and harvesting; statistics of products and of prices.

Class 3. Oats.

Class 4. Barley.

Class 5. Rye.

Class 6. Rice and its culture.

Class 7. Buckwheat and other grains.

Class 8. Grasses, various species; hay and hay-making.

Class 9. Forage plants—clover, alfalfa, cow-pea, cornstalks.

Class 10. Ensilage—silos, &c.

Class 11. Flours, meals, decorticated grains, grits, &c.

Class 28. Potatoes, sweet potatoes, yams, &c.

Class 29. Sugar, beets, mangel-wurzel.

Class 30. Carrots, turnips, beets, artichokes, &c.

Class 31. Peanuts; methods of cultivation, statistics, &c.

Class 32. Broom corn, pumpkins, squashes, pease, beans, as crops.

Class 17. Sugar-cane, its cultivation and treatment; manufacture of sugar.

Class 45. Tea, coffee, cocoa, chocolate, and substitutes.

Class 46. Hops; culture, statistics, &c.

Class 48. Tobacco in the leaf, and tobacco not manufactured.

Class 53. Cotton on the stalk—its several varieties; long and short staples, shown by living examples, by engravings, photographs, &c.

Class 54. Methods of planting and culture.

Class 59. Hemp, flax, jute, ramie, and other vegetable fibres not enumerated, in primitive forms and in all stages for spinning.

Class 60. Wool in the fleece, in sacks and in bales.

Class 61. Silkworms, silk in the cocoon; apparatus and appliances used in silk culture.

It is the desire of this Department that the exhibit of these products be as complete and exhaustive as it is possible to make it; in brief, that it shall include illustrations, with methods of culture, &c., of the leading varieties grown in every part of the civilised world. A very complete exhibit of this character will be made from all the States of the United States; and the co-operation of the various State Commissions in this work has been fully accorded this Department, and the work of preparing the same is now being carried on.

Among important features, it may be mentioned that there will be a special display of potatoes and other tubers during the two weeks beginning Monday, September 11, 1893, and a special display of sugar beets during the two weeks beginning October 9, 1893. These will be in addition to the regular exhibit, and will be of products grown during 1893. Illustrations of planting, harvesting, important processes connected with the manufacture of food products, systems of irrigation and drainage, and all subjects connected with farm work will be presented in proper form. In brief, there will be an exhibit from this country which will fully illustrate the progress made in agriculture, and the productive capacity of the soil of the different States.

It is the earnest desire of the Director-General, and of this Department, that an equally complete and comprehensive exhibit of farm products shall be made by all the nations which will take part in the Exposition. With the earnest and active co-operation of foreign Governments, an exhibit of farm products may be made which will give visitors a clear and definite idea of the world's progress in agriculture, and afford an instructive object lesson as to the best methods to be employed in cultivation, and other valuable information.

Exhibits of cereals should be accompanied by the following information:—(*a*) Name of object; (*b*) name of producer; (*c*) place where grown; (*d*) character of soil; (*e*) date of planting; (*f*) quantity of seed planted per acre; (*g*) method of cultivation; (*h*) date of harvesting; (*i*) yield per acre; (*j*) weight; (*k*) price of product at nearest home market; (*l*) average temperature, by months, for the time intervening between planting and harvesting; (*m*) average rain or snow fall, by months, for the time intervening between planting and harvesting; (*n*) was exhibit produced by irrigation?

May I request you to ask foreign countries to include in their exhibits specimens of farm crops in such quantities as they may decide upon, as indicated above, and thereby add to the general interest of the Exposition.

This Department will gladly furnish any information desired relative to such an exhibit, and will be obliged if you will request a reply to this letter.

I have the honour to be,

Very truly yours,

(Signed), W. I. BUCHANAN,

Chief, Department of Agriculture.

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, January 21st, 1892; Sir W. W. HUNTER, K.C.S.I., in the chair.

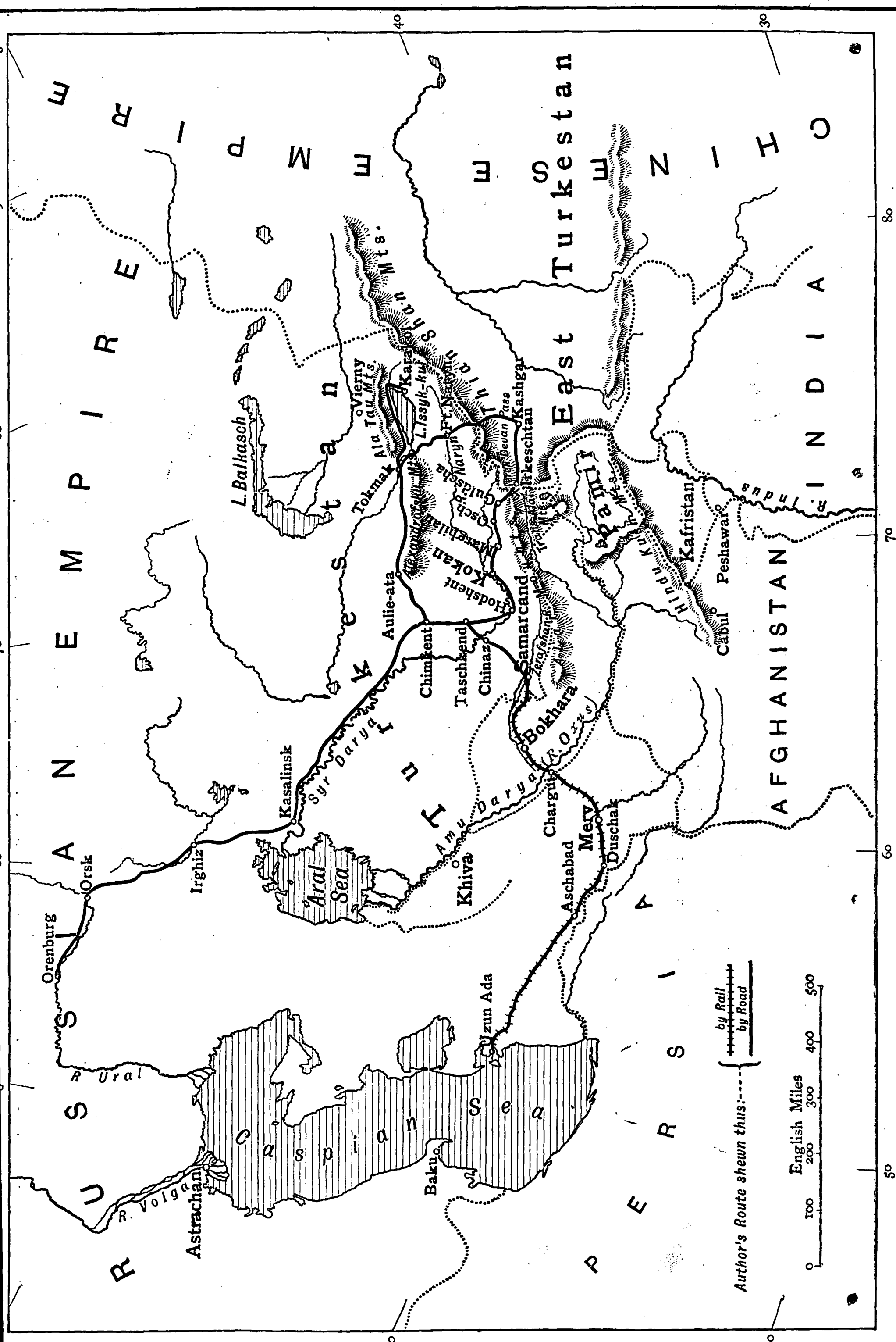
The paper read was—

FROM TIAN SHAN TO THE PAMIRS: EXPERIENCES ON THE RUSSO-CHINESE FRONTIER.

By HERBERT JONES.

Events sufficiently well known to the members of the Society of Arts have recently attracted the attention of the civilised world to the remote highlands of Central Asia, through whose solitudes are now traced the somewhat uncertain boundary lines of three great empires, the British, the Russian, and the Chinese.

To Englishmen the main points of interest are doubtless those connected with the frontier of our Indian Empire, and of the States immediately adjacent thereto. But this part of the Asian highlands did not come within the scope of my journey; it has, moreover, been recently treated of by some of our greatest living authorities. I propose, therefore, in the present



Walker & Boutall sc.

paper, briefly to describe my own impressions of that portion of the Russian Empire which abuts on the Chinese frontier, from the western slopes of the Tian Shan to the valleys of the Trans Alai, which form the approaches to the Pamirs from the north.

This portion of the Russo-Chinese frontier may be fairly described as a scientific one; excepting the comparatively level country up the valley of the Ili leading to Kuldscha, the frontier is traced along a line of practically inaccessible mountain peaks and ridges, intersected by a few passes such as the Narinkol Musart, Bedel, Turugart, &c., difficult not so much from their height (some 11,000 or 12,000 feet) as from the absence of roads and bridges on both sides of the frontier.

But further south the frontier lines between the Russian province of Ferghana and the Chinese one of Kashgar are drawn so that the important Terek Davan Pass (13,500 feet) is entirely within Russian territory; and the Cossack fort of Irkeschtam, which marks the Russian boundary on the road to Kashgar, is practically among the foothills which bound the Kashgar plain, and also commands the head waters of the Kizil Su. This river flows down the Alai valley, which is bounded on the south by the ranges of the Trans Alai and Mustagh Tau mountains, with the Kizilart and other passes leading up to the series of table lands and ravines known as the Pamirs. This Russian territory is divided into two portions by the River Naryn, as the upper reaches of the Syr Darya are called, into the province of Semerechia (in English, Seven Stream Land), to the north of the River Naryn, and the province of Ferghana, to the south of it, a country which, prior to the Russian occupation, formed the Khanate of Kokan.

Semerechia bas been described by Russian writers as an "Asiatic Switzerland;" it might with more accuracy be termed an "Asiatic Colorado."

The average temperature approximates to that of southern Germany; but the maxima of heat and cold exceed those of central Europe. Owing, however, to the elevation of the greater part of the country above the adjacent steppes of Turkestan, the extreme summer heat which afflicts the lowlands is not experienced in Semerechia; and the pure dry mountain air and bright sunshine cause the sharp frosts of the short winter season to be less felt.

Although the winter snowfall is sometimes considerable, the dryness of the atmosphere obviates the fearful discomfort of the spring thaw, which, in European Russia, converts roads into impassable quagmires, and town streets into rivers of liquid filth, laden with the accumulated refuse of a five months' frost.

Here, on the contrary, the sun evaporates rather than thaws the snow, and a couple of days' warm wind towards the middle of February causes the snow to vanish from the plains like the shadow of a cloud, leaving only a drift here and there in the hollows of the ground, through which the steppe crocuses are already pushing their impatient heads.

The snow on the foot hills disappears in March, causing a considerable rise in the rivers, which then subside to their normal depth until towards the end of May, when the thawing of the snow on the high alps and glaciers causes a second and still greater rush of water. The absence of bridges, and the fact that the approaches to many of the passes lead up ravines which form the bed of a mountain torrent, render this second flush a very troublesome obstacle to communication in summer, especially in some directions where, owing to the extreme steepness of the mountain slopes, the roads are closed altogether in winter by avalanches.

The mountains of Semerechia may be described as the western spurs of the Tian Shan, the chief of which are marked in our maps as the Ala Tau and Alexandrofsky ranges.

The Ala Tau ranges are divided by Lake Issik-kul into two divisions, known respectively as the Kungei (sunny) Ala Tau on the north of the lake, and the Ters (shady) Ala Tau to the south of it.

In this dry climate rain is almost unknown, and vegetation depends on the snow accumulated on the mountain slopes. Those slopes which are exposed to the sun soon lose their moisture, and they and the plains beneath are soon parched into absolute barrenness; but wherever the snow lies there trees can grow, which in turn afford further protection to the mountain stream.

Although Semerechia derives its name from its rivers, these are geographically less interesting than the lakes of fresh, brackish, and salt water with which the country abounds. First, in point of size, is the great lake Balchash, but its position far out in the barren steppe deprives it of any economic importance, in which respect by far the most important is Lake Issik-kul, a magnificent sheet of slightly brackish water, some 120 miles long by about 40 broad at its widest part. Issik-kul is about 5,500 feet, Lake Sairam Nor, in Kuldscha, 7,200,

and the lonely Son Kul, in the south of the province, 9,400 feet above sea level. The larger lakes are usually brackish, and small lakes of very salt water are found in various parts of the province.

A description of Semerechia would be incomplete without a reference to Kuldscha, a Chinese province on the upper waters of the Ili river.

This fertile oasis in the midst of the Mongolian wilderness of rocks and deserts presents a striking parallel to the position of Egypt in another continent. Like Egypt it is renowned for its climate; the traveller from Turkestan sees the last of the grapes which so abound in the southern provinces when he reaches Chimkent, and whilst Vierny, the capital of Semerechia, is famous for its apples, the Issik-kul valley has not yet succeeded in producing this fruit. But at Kuldscha, considerably further north than both of these places, both apples and grapes grow and ripen freely in the open air, owing to the protection of the mountain ranges of the northern Tian Shan.

Moreover, Kuldscha was the home of an industrious Mohamedan population, which drove out its rulers at the time of the Tæping revolt, and the subsequent disorders led to foreign intervention. Russian troops occupied for a series of years the province, the key and granary of Western Mongolia, and in reply to the protests of China, that power was assured that as soon as she could give satisfactory guarantees of the maintenance of order on the frontier Kuldscha would be restored to her. These conditions having been fulfilled, the Russian Government has honourably carried out its undertaking, and the Chinese have resumed possession of the revolted province.

In view of the criticisms of Russian earth-hunger, of which we hear so much at present, this retrocession of Kuldscha should not be overlooked as a fact on the other side.

The troubles in Kuldscha had considerable influence on the population of Semerechia, because the Chinese Mohamedans, known by the name of Dungans, mostly elected to follow the Russian troops, and quitted the country rather than submit again to the Chinese Mandarins. On the other hand, some nomad tribes of Kalmucks, who previously dwelt in the steppe around the north end of Lake Balkash, have transferred their allegiance to their Buddhist co-religionists in Kuldscha.

The aboriginal mountain population of Semerechia are Kara Kirghis, of the division called Diko-kammenye (Wild Mountain), but in the steppe beyond Vierny, there are many Kazak Kirghis. The mountain Kirghis are a more settled people than the nomads of the steppe, to whom they are distinctly superior, both physically and mentally; they are a good-tempered, indolent race of shepherds and cattle tenders, excellent riders, and fond of field sports, especially horse-racing and falconry. Although in many places they are sufficiently settled to house their stock in sheds in winter, they almost invariably retain the *yourt*, or felt tent, of the steppe for their own residence.

The native townspeople are of the mixed race, known throughout Turkestan as *Sart*, a people, doubtless, of Tajik (Iranian) origin, but so mixed with Tartar and Mongolian races, that the original type is often scarcely recognisable.

The Dungans—already alluded to—are a brave, honest, and industrious people, which has already made its influence felt as far as Taschkend and beyond. They have become the carriers of Central Asia, wherever wheeled transport is possible; and their trustworthiness is so much greater than that of the Russian peasants, or Sart Arabadgis, that they have almost monopolised the trade in the north.

The Russian colonists in Semerechia are a very heterogenous body, but are divisible into two main sections—one composed of peasants, chiefly from the Tomsk and other Siberian Governments; the other, military colonists, time-expired soldiers, and Cossacks.

The general appearance of these settlements is not creditable to the inhabitants. Surrounded with every advantage of fertile land, plenty of water, wood, and building material that a colonist could desire, the moujik remains precisely the same shiftless, slovenly, unprogressive creature as before. It would cost him next to nothing to build a decent house, but he and his family still herd together in one little room, like a litter of pigs; he has not a bed to sleep on, nor a chair to sit down upon; and the meanest Kirghis *yourt* is more artistically decorated than his grimy unventilated *izba*. His farmyard is kneedeep in dirt, and his cattle pens are built, if possible, beside a running stream, so that he can throw the manure into it and have it washed away without further trouble. The profits of his abundant harvests are spent in disgraceful orgies, the immediate excuse for which is usually a wedding in the village. The demoralisation induced by these Bacchanalian habits is spreading from the Christian to the

Mohamedan population, and is causing a serious increase in theft and other crimes on the part of the hitherto orderly Kirghis.

Considering that Russia has now been in undisturbed possession of this glorious country for well on to half a century, and has, moreover, the advantage of direct water and rail communication by the Volga and Kama to Perm, and the Ural railway to Tioumen, and thence by river right away to Semipalatinsk on the frontier of the province, its present backward condition seems scarcely commensurate with the resources of its possessor, or the general progress of the world. Did time permit, it would be interesting to compare the development of this land under Russian auspices, with that of another, whose settlement under British influence and not very dissimilar conditions, commenced about the same time—I refer to New Zealand. I will only remark that our colony has solved the question of the disposal of its surplus flocks and herds, whilst cuts of beef are still selling in Karakol for 1½ copecks per pound for which people in Moscow are paying over 50 copecks, whereas Russian cheese is retailed in the Central Asian shops at 60 copecks per pound, in a land where the value of a cow is 8 roubles or in other words less than the price of a single stone of cheese. The Russian government does all in its power to improve agriculture, but all efforts have failed to overcome the stolid apathy of the settlers.

My own acquaintance with the Semerechia province dates from November of 1890, at which time I arrived there along the post road, which runs from Samarcand and Taschkent to Vierny and Semipalatinsk, on the Irtish river. It was not an agreeable journey at that time of year. From motives of economy the supply of horses on the road has been reduced to the absolute minimum necessary to carry the mails, and the hopeless traveller is condemned to pass weary hours at wretched little desert stations waiting for a relay of horses. Passing at last the little town of Tokmak, I diverged from the north road and commenced the ascent of the ravine of the Chu river by a military road, made a few years ago by Russian engineers, and looked upon as one of the most difficult engineering feats in the country. This ravine is known as the Buamsky Uschelye, and is a deep gorge or canon, through which rushes the Chu, an eccentric stream, which is widest and deepest at its upper end, but which gradually dwindles lower down, until it disappears in a swamp in the desert. The view which presents itself to the traveller, as he emerges from the canon of the Chu into the broad Issik-kul valley, is one of the most striking in the world. Around him tower the bare rigid heights of absolutely barren mountains, grey, blue, yellow, and red, according to the rock of which they are composed, without a blade of grass to diminish the effect of their vivid colouring. Immense moraines of boulders and gravel slope down to the azure blue surface of the lake, whilst the snow-clad heights of the higher ranges on the Chinese frontier, cold and clear against the glowing Western sky, complete a landscape to which I am unable, in my own experience, to quote a parallel.

Continuing along the post-road eastward on the north shore of the lake, the traveller crosses a wide steppe tenanted by flocks of bustards and other wild birds, and a few Saiga antelope, with occasional Kirghis encampments. The first Russian village is located about midway from each end of the lake, from which point a series of settlements, at about 25 versts apart, are placed along the post-road to Karakol.

This town, now officially designated Prschevalsk, in honour of the celebrated Russian explorer, who died there, is a quiet little garrison town, with wide, straight streets and small one-story houses. However small its importance, politically or commercially, it is an interesting spot to the traveller, who sees here a meeting-point of three civilisations, existing amicably side by side without strife or fusion.

The lower end of the town is occupied by the spacious houses, with more or less elaborate wooden verandahs and pagoda-like roofs, of the Dungan merchants, Chinamen in everything but religion, who have a mosque of their own, and keep apart from the Sarts, whose squalid mud hovels occupy another part of the town. The whitewashed cottages of the Russians occupy the remaining streets. Contrary to the usual procedure in Russian towns, these houses show a reversion from brick and clay to wooden walls, all the newer houses being built of logs in the well-known Russian style. Even the church, dignified by the name of a cathedral, is now closed, and service is performed in a wooden chapel adjacent.

The ruinous state of the villages on the road will have prepared the traveller for this state of things. The one drawback of the country is the fear of earthquake, which is

perpetually before the inhabitants. The great shock three years ago, which laid every house in Vierny in ruins, did great damage in the Issik-kul valley; but Karakol, not being on the line of seismic disturbance, escaped with comparatively little injury; but the small village of the Ui Tal, near by, lost more than a dozen persons out of a population of some 200 souls.

The fruitful soil of the Issik-kul valley produces grain far beyond the requirements of the settlers, who live in hopes of military operations on the frontier, to give them a market for the contents of their overflowing granaries. Horses, sheep, and cattle are equally cheap. On the other hand, manufactured articles are usually about double the prices at which they are retailed in Samarcand, except the indispensible vodki, which is distilled in Vierny, and third-rate beer, brewed in Karakol. It is characteristic of Russian commercial insight that the only large factory visible on the north road is one at Chimkent, erected a few years ago for the production of santonine on a scale which speedily overstocked the whole civilised world with the drug, and the factory had to be closed for want of a market; whilst soap, candles, sugar, matches, cloth, and so forth, are still being imported from Moscow and Poland.

Among the natural products of the Issik-kul valley I may just mention two characteristic ones.

Honey of excellent flavour is obtainable in any quantity by those of the settlers who are sufficiently intelligent to keep bees. The price of the finest quality is about 10 copecks per lb., as against 25 copecks for sugar.

The valleys round about have long been noted as headquarters of the royal eagle, known locally as the "Berkut." These magnificent birds are caught and trained by the Kirghis to capture deer, foxes, and wolves, and are greatly valued by the natives; a good eagle is considered to be worth several horses, and they are in request all over the steppe, and even in Persia and the Caucasus.

In Karakol, as in most other places throughout my journey, the Russian officers, both civil and military, received me in the most friendly manner, and I passed three months there in shooting excursions into the surrounding country, a thoroughly enjoyable time despite the late season of the year.

Having resided in Russia for years, and travelled thousands of miles, unattended and unintroduced, in various parts of the empire, I have had considerable experience of Russian Tchinovinks. In no single instance have I been received otherwise than courteously, and I can recall many instances of friendly consideration quite beyond mere official politeness. The attacks of Jews and Nihilists on the Russian beaurocracy obtain such prominence in the English press, that I feel bound to state my experience in this respect.

Early in February, 1891, I set off on horseback, on my journey from Karakol to Kashgar. As there is a post-road as far as Fort Naryn, I did not take a guide, relying on getting one at the frontier. The road to the Naryn branches off the Karakol tract at the station of Kutemaldi, passes along the west end of Issik-kul, and winds through a series of bare rocky defiles and upland villages, inhabited only by Kirghis. The journey passed without special incident, except the unpleasant experience of a *buran*, what Americans call a blizzard, until I reached the Dolan Pass, not very high, but with a steep descent on the far side, one sheet of ice from top to bottom. Here my horse showed signs of giving out, but I succeeded at last in getting to the station. About 20 miles short of Fort Naryn, however, he stopped again, and I should have probably been all night on the road, had not an empty sledge come along and assisted me.

Fort Naryn is a bare, little place, inhabited by a small garrison and a few Russian and Sart traders. Owing to its height above the sea (some 7,000 feet), and the position of the surrounding hills, it has a very severe climate. When I was there the thermometer registered equal to 27° below zero, Fahrenheit.

I stayed at Fort Naryn for about a week, and obtained an escort of a couple of Cossacks, purchased a few provisions, and set out for Kashgar.

The first stage on the north road is to the village of At-Bashi, the last settlement on the Russian side. As the road is practicable for sledges so far, some of the officers accompanied me, and we had some duck shooting in the valley, which abounds in hot springs. About noon next day we took our leave, and rode up long sloping valleys, and over low hills till evening, where we halted at a rough Sart dwelling.

The station was crowded with a large camel caravan, of which we met several more further on, because all the camel caravans reach Kashgar by this north road, the southern track over the Terek Davan being only available for horses. These caravan camels are the best

and strongest animals obtainable; weak, half-fed beasts, such as you see on the lowlands, cannot stand the hardships of the road.

No beast of burden requires more care to keep it in condition than a camel, and if it once gets weak it requires months to get it into condition again. The drivers take great care of their beasts, and keep them warmly clad in thick felt; even the donkeys on which the merchants ride are jacketted to the tips of their ears—horses and cattle go unclad.

The caravan carries all supplies with it, down to hay and firewood.

It was curious to see the drivers dosing their camels with oil, to keep them in condition. One holds the animals head whilst the other pours the oil down its throat from a bottle, the patient meanwhile spluttering and roaring like a naughty child over a dose of cod-liver oil.

Next night we camped in a Kirghis *yourt*, erected in an old fort at the foot of the Tasch Rabat Pass. On the way we passed many parties of labourers with their few belongings loaded on a donkey, tramping to the Naryn. I learned they were bound for Vierny, where they would hire out to the Russian colonists for the summer. It shows the destitution amongst the poor in Kashgar when able-bodied men are willing to undertake a journey of nearly 500 miles over one of the worst roads in the world to work for strangers at six or seven roubles (12 to 14 shillings) per month.

Next day we climbed the Tasch Rabat Pass, about 11,000 feet high, with a lot of ice at the foot, and descended on to Lake Chatyr Kul, which we crossed on the ice, and beyond it we climbed another pass. At the top are visible two small cairns of stones, the boundary mark of the two empires. The view from this point was one I shall never forget. Far below us the valley of the Touyoun river stretched to the horizon; to the right lay a wilderness of wild bare mountains, whose rigid outlines looked as if they might have been turned out of a mould like an iron casting; whilst on the left, or north-east, rose range over range of the main Tian Shan chain. Passing over the further incidents of the journey, I may say I arrived in Kashgar on the 2nd (14th) March and dismounted at the Russian Consulate there, where I had the pleasure of making the acquaintance of Mr. Petrovsky, who has for many years represented not only Russia but the civilised world in what is, in more senses than one, one of the "dark places of the earth." Himself, one of the most successful of Russia's representatives abroad, Mr. Petrovsky's influence in Kashgar is popularly supposed to be not second to that of the Chinese Dao Tai himself; he, nevertheless, understands to maintain excellent relations not only with the Chinese authorities, but with the Englishmen who occasionally find their way there, and other Europeans have frequently been indebted to him for kindly assistance and advice in dealing with the local mandarins. Russian traders have the right to circulate freely in Kashgar, but other foreigners are not allowed in the country except by special passport from the Isumgli Yamen in Pekin.

This privilege, however, does not appear to have proved of as much practical use to the Russians as might be expected, and I was informed that the few Russian merchants who had attempted to open stores in the city had been compelled to give up the enterprise owing to the tacit agreement among the traders to boycott any European endeavouring to break their monopoly of the import trade. On the other hand, the bazaar contains a large number of Hindoo and Afghan merchants, and the Indian element appears to occupy itself more with actual trade than with money-lending, the main business of the Hindoos in the cities of Turkestan, where they appear to take the place generally occupied by the Jews in European cities. Russian roubles, Indian rupees, Chinese cash, and the native currency, "carcans," are all current in Kashgar.

The recent appointment of a British Consul in Kashgar is an excellent step, only too long delayed. At the time of my visit, the Britisher was made to feel, in various ways, that he must take a back seat, and although, of course, the English intercourse with the country is small, yet the total number of Indian subjects interested in the country is considerable. The poverty of the country is, however, so great that the internal trade does not amount to much, and the Chinese and Russian Governments have stopped the transport of goods from British India into Turkestan, which used to pass this way. The custom-house at Irkeschtam prohibits the import of Indian cotton goods, and the Chinese have stopped the tea caravans from Assam.

I found a small British colony established at Kashgar, two English sportsmen having come up from India in the autumn; Capt. Younghusband and Mr. Macartney were also in the country, but, at the time of my visit, only one gentleman was at home. Having been out of reach of news for some time, it was an unex-

pected treat to see English newspapers, only two months old, in this out-of-the-way place.

After a three days' stay in Kashgar, I resumed my journey. The courier who takes the mails to Osch twice a month was starting, so I took the opportunity of accompanying him. The road on Chinese territory to the frontier fort of Irkeschtam presents no special difficulty.

At the frontier I hired a couple of baggage ponies, to help us over the passes, and purchased various supplies, including a load of firewood, as we should have to camp out under the main pass. The road goes over two lower passes and up a long winding ravine, forming the bed of a frozen stream. The going was abominable; the ice lower down was flooded, and partly thawed, and the horses were constantly breaking through, whilst higher up it was firmer, but very slippery.

Thoroughly tired out, we arrived at length at this camping ground, a bare rock at the foot of the main pass, littered with bales of goods, which had been abandoned by some caravan, but without any protection against the weather. Violent snowstorms cause loss of life at this point nearly every year, but nothing is done. It is safe to say, that in no other Christian country would so important a road be left in such a neglected condition.

After supper we made up a good fire, and lay down to get what sleep we could. I dozed off, and dreamed a bear was biting my toe off, which I found, on waking, meant that I had put my feet too near the fire, and the soles of my felt boots were frizzling. About 3 a.m. I rose, as it was too cold to lie still any longer; and we crouched over the remains of the fire waiting for daylight. As soon as we could see our way, we drank some tea, saddled the horses, and resumed our journey, and about 10 o'clock stood on the top of Terek Davan, 13,500 feet high. The horses appeared to suffer from the thinness of the air, but the day was fine and fairly warm, and we dismounted and made our way down the steep slope on the other side on foot.

All the rest of the day we were descending from the ice-bound solitudes above into the warm springtime of the valley beneath, green with the new grass, and ringing with the songs of the birds. It was like passing in a single day from Christmas to Easter.

The Terek Davan Pass may be regarded as one of the approaches to the Pamir regions; From Irkeschtam there is an easy road down the valley of the Alai, at the upper end of which lies the Kizilart Pass through the Mustagh Tau range. This route, which skirts the Chinese frontier, passing lakes Kara Kul, Rang Rul, and Victoria, is one of the most important in the territory claimed as Russia, and the valley of the Alai can be reached from Marghilan direct by the Tenghis-Bai Pass, and from Samarcand, the railway terminus, up the valley of the Zerafshan.

Generally speaking, the Russian approaches to the Pamir present no especial difficulties in suitable weather; although not at present available for wheeled vehicles, they could doubtless be made so, and the rich provinces of Ferghana and Samarcand could furnish all the supplies which could be transported over them. On the other hand, to make roads adequate for heavy wheeled traffic from Osch Marghilan, and Pendschakent, the present termini of the post-roads, would require a large outlay and considerable time. The state of the Terek-Davan, the main pass into Kashgar, leads to the inference that the other passes, at present used practically only by the Kirghis shepherds, are still less improved, and all these routes are dangerous, if not impassable in bad weather; heavy snowstorms are liable to interrupt the communications for a considerable time

There is a small garrison at the fortified post of Guldscha, but the first Russian town on this road is called Osch. The native place is of considerable antiquity, but the Russian town is brand new, and provided with civilised shops, post-office, telegraph, and other appliances of civilisation. Here I took leave of my guide, the Tartar courier, and rode due west for two days to Marghilan, the Russian capital of the new province of Ferghana, formed out of the old Khanate of Kokan. The inhabitants regard it as a model city, and its wide streets are bordered by avenues of lofty poplars, of such a height that it seems incredible that all this luxuriance is the growth of some fourteen years.

After a week's stay in Marghilan, to rest my horse, I rode to Kokan, also a comparatively new city, but one of the most important trading centres in Central Asia. The activity in its large bazaar and in the caravanserais of the various European forwarding companies, indicate the prosperity to which it might attain were it connected by rail with Samarcand. At present, it costs nearly as much to forward a bale of cotton to Nijni Novgorod by the Trans-Caspian Railway and the Caspian, as to carry it to Orenburg, over 2,000 versts away, by camel caravan, and thence by rail and river.

Tobacco growing would have a great future before it in this country, if the excise regulations were less restrictive. The silk industry has received a good deal of attention of late; and the Government is trying to encourage improved methods of culture, and the introduction of Italian grain to replace the native sorts. But the apathy and ignorance of the Russian trading and agricultural classes wrecks the improvements introduced by intelligent Government officials, whose efforts appear of little avail in view of the low standard of comfort to which the lower class Russian is accustomed, and the absence of incentive to effort, due to the fertility of the land and the exclusion of foreign competition.

From Kokan I rode to Hodschent, and from there to Dschau Boulak, on the Taschkend road. My horse was now nearly worn out, and progress very slow, and, to add to my discomfort, it began to rain. So I disposed of my steed to the Starost (postmaster) at the next station, and completed my journey to Taschkent on wheels, having been 48 days, including stoppages, on the way from Karakol, and ridden nearly 1,000 miles over some of the worst roads in the world.

From Taschkent I travelled to Samarcand, and thence to the Caspian by the well-known Trans-Caspian Railway. Englishmen and Russians have not unnaturally regarded this great work chiefly from a political point of view, and indeed only an actual eye-witness can adequately realise what this great work, the one really new factor in Central Asian existence since the time of Tamerlane, is doing in arousing to new life this people, so long stagnating in isolation and tyranny. The awakening of the Sarts is slow: here, just as in the other alien provinces of the empire is visible the striking inability of the Slav race to impose its civilisation on others except by brute force; but when the present military government of these fertile lands, which at present strangles private initiative by official red-tape, is replaced by the freer conditions of the civil law, and the railroad extends its civilising influence to the other provinces of the State, this dark corner of the earth will commence to take its natural place in relation to the general progress of the world.

DISCUSSION.

Admiral Sir Erasmus Ommanney, C.B., F.R.S., said he had been extremely gratified with this very interesting paper, especially as it referred to a portion of country which had only lately been brought prominently to the public notice. Some parts of the description reminded him somewhat of the coast of Greenland, and he should like to know whether the roads over the tremendous elevations described were at all passable in the winter season, and, indeed if the villages were inhabited at that time of the year. It did not appear as if there had been much cultivation along the route of the Samarkand Railway.

The Rev. Dr. Lansdell said Mr. Jones had been over ground with which he was quite familiar, and he could confirm the accuracy of almost everything which had been said. He was not quite sure whether the eagle, locally called the *berkut*, and used for sporting purposes, was the *Aquila Imperialis*. He obtained in the Musart Pass a very fine specimen, which was now in the Museum of Natural History, South Kensington, where they termed it *Aquila Chrysaëtos*, or Golden Eagle. His impression was that it is the largest kind used for hunting, even such great animals as wolves and small deer. He was very glad to hear the tribute paid to the kindness shown by the Russian officials to English travellers, because there was abroad so much misrepresentation of Russia, so that those who could speak to the contrary ought to do so. Similar testimony had been borne by Mr. Littledale in his paper before the Royal Geographical Society. When he (Dr. Lansdell) was at Tashkent the Governor-General instructed the officials at Osh that if any telegrams came for him they were to be sent on. After passing Kashgar he went round to the Taxin valley, Karghalik, and there he received a letter and telegram which had been sent after him something like 300 miles. When Mr. Littledale was on the Pamir a postcard was sent on more than 100 miles after him. Unless he was greatly mistaken Mr. Jones was the first Englishman who had been over the Tian Shan mountains from Vierney to Kashgar, if not also the first who had gone over the mountains from Kashgar to Osh. Major Cumberland certainly crossed in that direction, but he passed up the Gez defile.

Mr. W. Martin Wood said the paper was so extremely full that there was very little left to say, but there was one incidental question he might ask, viz., the duration of the winter in that region, where Mr. Jones spoke of the melting of the snow in February. It was generally understood that in those regions the summer only extended to three or four months, and that the rest of the year was severe winter weather, and in some parts excessively stormy. The map which had been shown was not quite on as large a scale as those that Lord Salisbury advised people to study; but it was sufficiently large to remind those who examined it that this region was far beyond the frontiers of India, and had no necessary communication with that country; in fact, the intervening portions separated the two countries most effectually. We had, unfortunately, to some extent

ourselves broken down that natural protection, and, as it were, made a way for anyone who wished to come into India to do so; but, it should be remembered, that the regions between those Mr. Jones had described and the frontiers of India, when the impediments and difficulties were considered, were practically hundreds of miles from the Indian border.

Colonel GOURLEY, M.P., said he had listened with much pleasure to this paper. Any information with regard to what the Russians were doing in Central Asia must be very interesting to Englishmen. As a rule, Anglo-Indians endeavoured to create on public opinion an unfavourable impression with regard to what the Russians were doing in that region, and their watchword generally was "wolf, wolf," the idea apparently being that the Russians were coming down like a thief in the night, for the purpose of robbing England of vast territories in India. He was quite certain, however, that whatever ideas might be entertained by some Anglo-Indians, the opinion held by thinking men and men who have visited Central Asia was, that the Russians would have very hard work if they attempted to invade India, not only because of climatic reasons, but also on account of the indomitable courage of our own people, backed, as they would be, by the Indians themselves. His view was that Russia was our neighbour in Asia; we could not help it, and therefore our policy should not be that of the majority of Anglo-Indians, always barking at Russia, and saying we were prepared to fight her, but agreeing with her as to what ought to be the friendly boundaries of the two countries in Central Asia.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., said that the Society of Arts were indebted to Mr. Herbert Jones for one of the most interesting papers ever read in their Indian Section. In the impression made by its simple truthfulness it recalled to his mind the late Mr. T. W. Atkinson's work, entitled "Explorations in Oriental and West Siberia," published by his widow in 1857. Mr. Atkinson was an accomplished artist, and gave some graphic illustrations of the *berkut*, or Imperial Eagle of Asia, which was so closely allied to the Golden Eagle that they might be regarded as but local varieties of the same species, and their names as synonymous. What struck the speaker, in looking at Mr. Jones's lantern photographs of the life, labour, and landscape of Central Asia, was the proof they afforded of the great commercial enterprise of the leading nations of antiquity. It was through Central Asia that the civilisation of Nineveh and Babylon were, as Professor De la Couperie has taught us, carried into China; and it was through Central Asia that Greece and Rome received their knowledge of China, until, later on, that country was also reached from the West, by way of the Indian Ocean. Of course it might be that Central Asia, in the process of the centuries, acquired a severer physical aspect and climate, through the gradual elevation of its surface by volcanic force, which Mr. Jones's paper proved was more active there than he, the speaker, had known before. One of the most pleasing features of Mr. Jones's paper was the high terms in which he spoke of the Russian administration, and the Russian officers in Central Asia. Certainly, we Englishmen could raise no objection to Russia occupying any part of Central Asia we did not want for ourselves; and, with this qualification, we should cordially welcome the advance of Russia in Central Asia, as an earnest of the revival of the great prosperity enjoyed by the people of these regions, all through antiquity and the middle ages, down to the conquests of the Mahomedans. He only regretted to find from Mr. Jones's photographs that the Russian type of civilisation so painfully resembled our own. Their public buildings were the very duplicates in thorough-going architectural depravity of those of the Indian Public Works Department; and certainly none of Mr. Jones's photographs gave him greater pleasure than the one representing the complete destruction by an earthquake shock of the Russian high school at Viernay. Were every Government church, high school, and school of art in India reduced to ruin by a similar seismic shudder, he for one would never cease to bless the beneficent discrimination of a congenial and considerate Providence.

Mr. JONES, in reply, said the Kirghis lived on these heights in their *yourts* all through the winter, though no doubt many of the old people died off. With regard to the *berkut*, he did not claim to be an ornithologist, but his information was acquired from a well-known German collector named Reichbeil, who collected for the Berlin Entomological Society, formerly on the Amoor, but was now resident not far from Karakol, and who was almost the only scientific man in that part of the country. At the same time he thought he knew sufficient of the golden eagle to say it was not that bird in the Karakol district. He did not know that they were capable of killing the great Maral stag, which was very rare, but they were perfectly capable of striking down a roe-deer. It was quite possible that his journey by way of the Naryn to Kashgar was the first by an Englishman, but with regard to the south road, it was the route by which most people who had gone to Kashgar in recent times travelled. He had the pleasure of meeting an English traveller, Mr. Beach, who had preceded him on that route when he travelled from Kashgar to Turkestan, and he met him on his return. His remarks with regard to the temperature might be a little misleading, but it depended entirely on the elevation. There was a great difference from that of the steppe, which was a little above the level of the sea, to that of the High Alps. The fact of the snow

disappearing in February was applicable to the Karakol Valley. It seemed to be evaporated by the sun before the end of the winter. On the Naryn they had the temperature of Greenland, and Mr. Reichbeil told him that he had recently discovered there a butterfly, a small colias, whose only other habitat was on the Greenland coast. He found this colias on the high slopes of the Tian Shan in April or May at or above the snow line.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Jones, said they had heard a good deal of late about the Russian Chinese frontier, and probably most had read the admirable contributions which Dr. Lansdell had made on that subject. To him the most interesting and welcome part of the paper was the testimony borne to the courtesy and friendliness of the Russian officials. They heard so much in this country against Russia that he agreed with Dr. Lansdell that it was well that the two gentlemen who had been on the confines of the Russian frontier, where there was no Press to take cognisance of what was going on, or to take the part of Englishmen if it was required, should come forward and say how they themselves found the Russian officials to act. He sympathised with the difficulties of Russian civilisation in such a country. They knew how hard it was in India to get Oriental races to take even moderate steps in the path of progress. If, with all the abounding fertility and splendid climate and immense population of India, our task was so difficult, how much more difficult must be that of the Russian pioneers in Central Asia. He agreed with Sir George Birdwood as to the obligation under which the earthquake had placed them with regard to the destruction of the high school; but fortunately it was only the building that was destroyed; the school itself he hoped would go on, in spite of earthquakes, and that Russia in Central Asia, like England in India, would base her progress on a sincere endeavour to educate the people. He felt confident that Russia had a great career before her in Central Asia, as England had before her in India.

The vote of thanks was carried unanimously, and the meeting separated.

APPLIED ART SECTION,

Tuesday, January 26th, 1892; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., in the chair.

The paper read was by WILLIAM MORRIS, M.A., on "The Woodcuts of Gothic Books."

The paper and discussion will appear in the next number of the *Journal*.

SEVENTH ORDINARY MEETING.

Wednesday, Jan. 27, 1892; R. BRUDENELL CARTER, F.R.C.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Ames, Thomas R. J., 49, Maury-road, Stoke Newington, N.
Browne, Rev. Canon George Forrest, B.D., 54, Bateman-street, Cambridge, and 2, Amen-court, E.C.
Bryden, W. R., 1, George-street, Buxton.
Buchanan, John Young, M.A., F.R.S., 10, Moray-place, Edinburgh.
Chubb, John C., 128, Queen Victoria-street, E.C.
Clarke, Somers, F.S.A., 15, Dean's-yard, Westminster, S.W.
Constable, Archibald, 14, Parliament-street, S.W.
Corder, William, Feeringbury, Westbourne-road, Edgbaston, Birmingham.
FitzGerald, Prof. Maurice Frederick, B.A., Queen's College, Belfast.
Gaymer, John, North Walsham, Norfolk, and John-street Adelphi, W.C.
Gujpatee, Rajah Goday Naraen, Rao, Vizagapatam, India.
Haden, William Nelson, Homefield, Trowbridge.
Halsey, W. S., 213, Cromwell-mansions, S.W.
Hawkins, Herbert Spong, London, Brighton, and South Coast Railway, London-bridge, S.E.
Hughes, John Griffith, Atlantic Engine Works, Bootle.
Kirkaldy, James, 68, East India-road, E.
Ledward, Thomas, 9, Pendrell-road, Brockley, S.E.
Macan, H., M.A., Imperial-buildings, Ludgate-circus, E.C.
Mackenzie, Captain R. J. H. L., R.E., Karachi, India.
Miller, Adam, 11, Queen Victoria-street, E.C.
Oppert, Dr. Gustav, Presidency College, Madras.
Pascoe, James Rogers, Pyrmont, Woodford-green, Essex.
Penfold, Harold, 14, Priory-road, Bedford-park, Chiswick.
Rose, Tom Kirke, 9, Royal Mint, E.
Rowell, Herbert, Hebburn-hall, Hebburn-on-Tyne.
Sibson, Alfred Edward, 2, St. John's-villas, Palmerston-road, Buckhurst-hill, Essex.
Thorp, Walter, B.Sc., The Limes, Henry-road, New Barnet.
Travancore, His Highness Sir Rama Varma, Maharajah of, G.C.S.I., The Palace, Trevandrum, Travancore, India.
Watney, Walter D., 33, Poultry, E.C.
Wilson, Captain Robert Charles Dighton, 21, Chesham-street, Belgrave-square, S.W.
Wilson, Walter H., Queen's-road, Belfast.

The following candidates were balloted for and duly elected members of the Society:—

Braddon, Sir Edward N. C., K.C.M.G., 5, Victoria-street, S.W.
Cowan, Thomas William, 31, Belsize-park-gardens, N.W.
Fitzgerald, Prof. George Francis, M.A., F.R.S., Trinity College, Dublin.
Hotz, A. P. H., Leacroft-house, Staines.
Potter, Walter F., 440, Kingsland-road, N.

The paper read was—

THE SCIENTIFIC VALUE OF LOVIBOND'S TINTOMETER.

By F. W. Edridge-Green, M.D.

From the time that colour first commenced to interest scientific men, a method which would enable us to match colours and keep a record of them for further reference and examination has been desired. The present system of colour nomenclature is unsatisfactory, as in fact all arbitrary systems of colour-naming must be, on account of the varying degrees of colour-perception which are met with in different individuals.

Colour is a sensation, and not an unalterable physical quality of bodies. The same substance may vary in colour according to the conditions under which it is viewed. The rays of light which give rise to the sensation are unalterable, and it is the suppression or admixture of certain of these rays that gives rise to changes in the colour of an object.

The Tintometer is an instrument consisting of two tubes placed side by side on a stand. Both tubes are open at each end. At one end is an eyepiece through which both apertures in the tubes can be viewed. At the ends of the tubes, opposite the eyepiece, is an arrangement for holding the coloured glasses and the substance to be measured. The coloured substance is matched with coloured glasses which are rose, yellow, and blue. The inventor has taken a glass very faintly tinted with each of these colours as a unit, and then constructed a series of glasses in sequence, in accordance with the number of units of the colour in each glass.

The instrument is used as follows:—In the case of transparent substances, a white porcelain plate serves for a background. The porcelain plate scatters white light in all directions, but gives a reflection sufficiently luminous for the purposes of the tintometer. On examining the light reflected from the porcelain plate with a spectroscope, it is found to give a continuous spectrum, the luminosity of the colours being diminished practically in the same degree. It is necessary that the spectroscopic composition of the light reflected from the porcelain plate be known, because a substance may appear white, without reflecting the spectral colours in an equal degree. Two or more of these colours may even be absent from the light reflected by a white substance. This fact may be demonstrated in the following manner:—Let a spectrum be thrown on a screen with the aid of a prism. If a lens be inserted in the course of the rays, so that they will be focussed on the screen, they will be reunited at the point of focus, and again form white light. If an opaque object be interposed, so that one set of coloured rays are cut off, the combination of the remaining rays will form a colour having a hue complementary to that of the intercepted rays. For instance, if the intercepted rays be yellow, the remaining rays will appear blue. If, however, the blue, as well as the yellow rays, be intercepted, the reconstituted beam of light will again appear white. It is evident, therefore, that the removal of one or more pairs of complementary colours from white light will leave the light unaltered with regard to hue, though the luminosity will be correspondingly diminished. A substance, therefore, may be white without reflecting all the rays of the spectrum, provided that equal portions of complementary colours be removed.

In estimating colour there is another point to be taken into consideration, and that is, if a colour be mixed with a large proportion of white light it will not be visible. Captain Abney has shown that the extinction of every colour is effected by white light, which is seventy-five times brighter than the colour. A pale wash of a pigment is not visible on white drawing paper.

When the colours of opaque substances are estimated by the tintometer, the comparison light is obtained from pure plaster of Paris carefully pressed in a small tray.

The coloured glasses used in the tintometer are of three kinds, rose, blue, and yellow. Coloured glass gives rise to its colour through absorption. When a beam of white light falls on a piece of coloured glass, part is absorbed and part is transmitted. On the screen is a spectrum of the blue glass, No. 16 according to the tintometer scale. It will be seen that there are three definite black bands, one in the orange, one in the yellow, and one in the green. These are called absorption bands, and are due to the fact that blue glass absorbs the rays of the spectrum which pre-

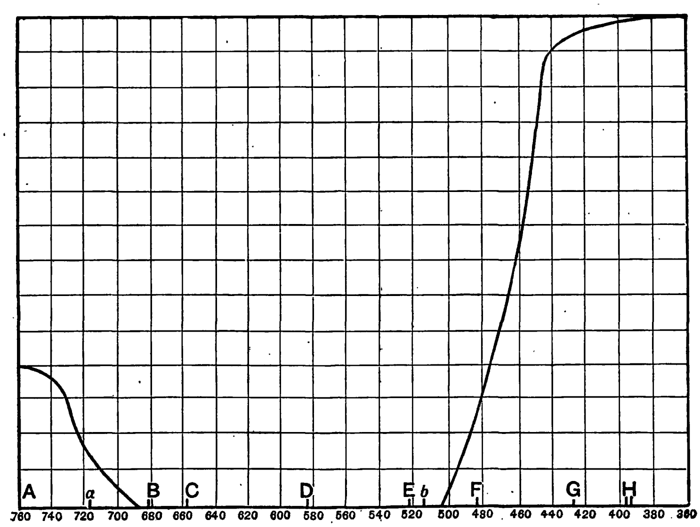
viously occupied the position of the black bands. The absorbed rays are probably converted into some other form of energy.

The colour of coloured glass is therefore a colour which has been produced by subtraction of certain constituents from white light. I showed in the first experiment that if any constituent colour be removed from white light, the residual light will appear of the complementary colour.

I will now draw your attention to the three figures representing the curves of absorption of the three coloured glasses. Absorption diagrams are usually represented by spectra with shaded bands of different depths to represent the absorption bands. It is almost impossible to represent an absorption spectrum in this way when any great degree of accuracy is required. We can more easily represent an absorption spectrum by a curve, the height of the curve corresponding to the degree of absorption. No substance is absolutely transparent to any of the rays of the spectrum. In all cases the absorption is only a question of degree. In the case of the diagrams representing the absorption of light by the tintometer glasses, the absorption by the rose glass is represented to 220° of the tintometer scale, that of the blue glass to 162°, and that of the yellow 207° We could make the curves quite complete by examining an increasing series until the transmitted light was too feeble to affect the eye. A curve constructed in this way would show the exact proportion of the constituents of white light transmitted by a coloured glass.

We have now to consider the cause of the difference in hue and shade of light when allowed to pass through several thicknesses of the same coloured glass, from that which it appears when transmitted through a single piece. If a coloured glass or substance absorbed certain rays of the spectrum, and those only, it would appear of the same colour in a thick layer as in a thin layer, because the thin layer would absorb these rays, and the effect of putting another thickness of glass in the course of the transmitted beams would be *nil*, as it could not affect any of the remaining rays of the spectrum. As I have previously stated, no substance is perfectly transparent to any of the rays of the spectrum, but there are substances which are opaque to certain spectral rays, and almost transparent to the remainder. These substances appear of nearly the same colour in a diluted as in a concentrated solution, in a thick as in a thin layer. Chromate of potash is one of these substances, and it appears very nearly the same colour in a dilute as in a concentrated solution.

FIG. 1.



ABSORPTION CURVE OF THE ROSE GLASS TO 220°.

THE ROSE GLASS.

The glasses of the tintometer therefore produce their colours as follows. Let us first consider the rose glass. If we take the weakest glass and examine it with a spectroscope, we find that the light is transmitted proportionately to the curve in Fig. 1, that is to say, the green is most absorbed, then the

violet, and so on. This glass will then correspond to the apex of the curve, and the resulting colour will be that of light with certain constituents removed in the proportions represented by the curve. Total absorption only takes place at the apex of the curve. It is evident therefore that if we allow the light to pass through two pieces of this glass the second piece of glass can only act on those rays which have passed through the first. As the coloured light absorbed by the second piece of glass is proportional to the heights of the curve, the absorption diagram of both combined may be represented by the curve with a portion of the apex removed. At the point of section there is total absorption. In this way by adding to the number of glasses we pass downwards towards the base of the curve, the sections indicating total absorption becoming larger and larger, and the amount of light transmitted through the glasses smaller and smaller. From this it is evident that a feebly-tinted glass transmits more red light than a glass of a much deeper shade. From the curve it will also be seen that the hue of the transmitted light becomes of a purer red as the number and depth of the glasses are increased, and the violet becomes absorbed.

Rose 22, when examined with the spectroscope, shows a dark absorption band, occupying two-thirds of the green. The violet is partially obstructed. The glass is almost transparent to the remaining rays of the spectrum.

When high combinations are examined, the hue of the transmitted light first changes to orange-red, and then to a pure red.

R. 22+21. Most transparent to red, orange, yellow, and yellow-green; opaque to green and blue green. Transmits blue and violet partially.

R. 22 + 21 + 20. Most transparent to red, orange, yellow, and yellow-green; opaque to green and blue-green. Transmits a few blue and violet rays.

R. 22+21+20 + 19. Transmits red, orange, and yellow partially; opaque to rest of spectrum.

R. 22 + 21 + 20 + 19 + 18 + 19·5 + 18·5. Transmits red and orange partially; opaque to rest of spectrum.

R. 22 + 21 + 20 + 19·5 + 19 + 18-5 + 18 × 17·5 + 17 + 16·5 + 16 + 16·5. Transmits red partially; opaque to rest of spectrum.

It will be noticed in all the diagrams that the absorption bands at the red end of the spectrum, as represented by the curves, occupy positions nearer the centre of the spectrum than they do in the corresponding spectra on the screen. This is due to the fact, that in a spectrum produced by a prism, the colours at the red end occupy less space than they should, having due regard to their wave-lengths. The figures in the diagrams indicate the wave-lengths of the various rays in millionths of a millimetre. The letters indicate the positions of the principal Fraunhofer lines.

The Blue Glass.

This glass is a pure blue in its lighter shades, but the deeper shades incline to violet. In still deeper combinations the hue inclines to reddish violet.

Blue 20 shows a dark absorption band occupying the red-orange, and another in the yellow. The remainder of the orange is nearly absorbed. There is an absorption band of medium depth occupying the central third of the green. The glass is almost transparent to the remaining rays of the spectrum.

In examining the lighter shades of this glass, the absorption bands occupying the red-orange and the yellow are the first to appear. (See Fig. 2, p. 216.)

B. 20 + 19. Almost transparent to band of red, blue, and violet. Transmits yellow-green and blue-green partially; opaque to rest of spectrum.

B. 20 + 19·5 + 19. Almost transparent to band of red, blue, and violet. Transmits blue-green partially; opaque to rest of spectrum.

B. 20 + 19·5 + 19 + 18·5. Transmits a band of red, blue, and violet partially; opaque to rest of spectrum.

B. 20 + 19·5 + 19 + 18·5 + 18 + 17·5 + 17 + 16·5 + 16. Transmits a band of red and violet; opaque to rest of spectrum.

The absorption is always in the same ratio, namely, that shown in the diagram, but as the other colours become absorbed, so do the red and violet rays preponderate, and so the colour becomes reddish-violet.

The great defect in this glass is that it absorbs the green to a very considerable extent. This in a great measure interferes with its utility in combinations.

The Yellow Glass.

This glass in its lighter shades is a pure yellow. Its deeper shades incline to yellow-green.

Yellow 16 absorbs the violet, but is almost

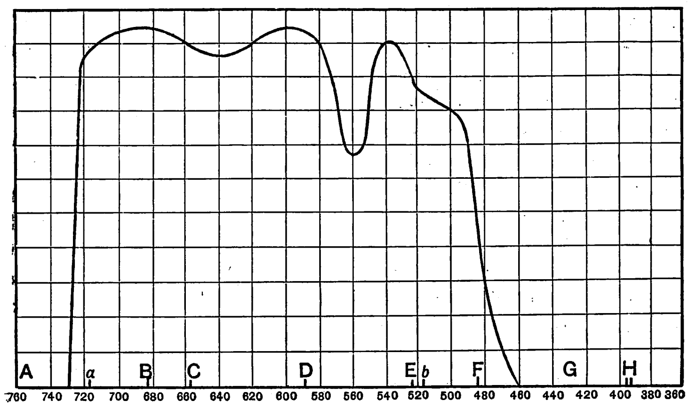
transparent to the blue and the rest of the spectrum. (See Fig 3.)

Y. 16 + 15·5 + 14·5 + 13·5 + 12·5 + 12 + 11·5 + 11 + 10·5 + 10 + 9·8 + 9·6 + 9·4 + 9·2. Most transparent to orange, yellow, and yellow-green; partly transmits green and orange-red; opaque to rest of spectrum.

This glass is one of considerable utility. Though in the deeper shades the yellow-green rays predominate, these are near the yellow, and so do not interfere with the practical usefulness of the colour.

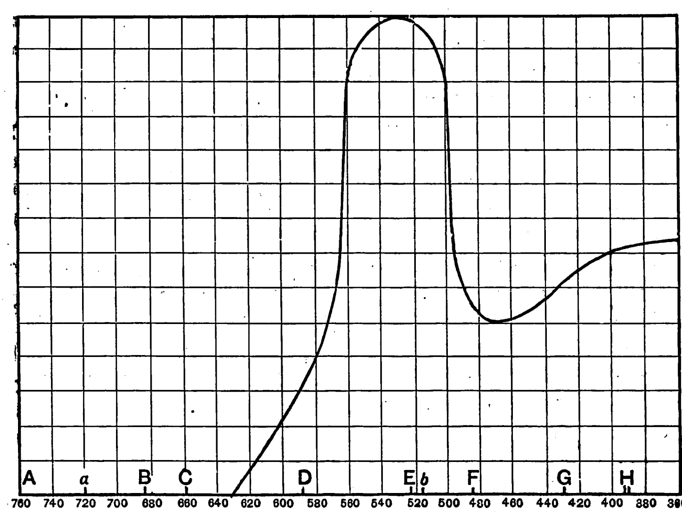
With regard to simple combinations.—B. 16 + Y. 16. = Green. Dark absorption bands are visible in the red-orange and yellow. Absorption band of medium depth in the centre of the green. Very little of the blue and violet can be observed. The yellow-green is seen

FIG. 2.



ABSORPTION CURVE OF THE BLUE GLASS TO 162°.

FIG. 3.



ABSORPTION CURVE OF THE YELLOW GLASS TO 207°.

best. An orange band and the terminal band of red are also seen.

B. 16 + R. 16 = Reddish-Violet. Dark absorption bands in the red-orange, yellow, and central green. The yellow-green is seen best. The remaining rays are partly visible.

R. 16 + Y. 16 = Orange. The blue and violet rays are absorbed. There is an absorption band occupying the central two-thirds of the green. Blue-green rays partly visible. Almost transparent to rest of spectrum.

The spectroscopic composition of any combination may be ascertained by adding together the absorption bands as represented in

the diagrams and deducting the whole from a complete spectrum. Mixture of the remaining rays gives the colour of the combination.

It will be seen that the best glass for the purpose required is the rose, which chiefly affects the green of the spectrum. The worst glass is the blue, as the absorption is not confined to one portion of the spectrum, and a number of green rays are absorbed. From this it will be seen that it is not possible to obtain a very bright green by combining the blue and yellow glasses.

The inventor claims that any colour may be matched with the instrument, and my experience confirms this. Colours, as, for instance, the aniline dyes, which are purer than those produced by the tintometer, may be matched in the following way:—The colour should be matched as nearly as possible with the glasses of the tintometer. When this has been done, the sample colour should be reduced, by adding glasses of the complementary colour to it. For instance, supposing the sample colour is a bright pure green: this should be matched approximately with blue and yellow glasses. Rose glasses should then be added to the colour to be matched, until it is brought within the range of the tintometer colours. It will often be found that the addition of the complementary glass or glasses to any colour will produce not only a change in luminosity, but also an alteration in hue. The reason of this is easy to comprehend. The yellow and blue glasses of the tintometer, when combined, make a green, because the yellow glass absorbs the whole of the violet rays, and so causes the blue to appear green, which is the colour produced by mixing the remaining spectral rays. Now, if this yellow glass be added to a blue, with the intention of reducing its luminosity, it will be found that the blue is not only reduced in luminosity, but that it has also become of a greener hue. This does not directly affect the record, but it does so indirectly, as will be explained shortly. The following example will show how, in practice, these matches are obtained.

A solution of methyl-orange in a $\frac{1}{4}$-inch cell being the colour to be matched. The colour of this was orange. The nearest match in colour was produced by R. 8·2 + Y. 48·5. The solution, however, was very much brighter. An exact match was made as follows:—Methyl-orange solution + B. 3·3 = R. 7·2 + Y. 48·5. It will be seen that when the blue was added one degree less rose was required.

With this and any other colour-matching instrument there is a source of error which has to be carefully considered, and it is due to two factors: (1) that colours appearing exactly alike have not necessarily the same spectroscopic composition; (2) that the spectral composition of daylight varies from day to day, even from hour to hour.

As an instance of a colour varying from these causes, let us consider a solution of chlorophyll which has been matched with a green, which, when examined spectroscopically, does not transmit any of the red rays. A solution of chlorophyll is transparent to a band of red at the end of the spectrum. If this match has been made at a time when the red rays were abundant, as at midday, the two colours would not match later in the day when the red rays were not so abundant. The red rays would be subtracted from one colour and not from the other.

This objection might be overcome if a fixed standard light could be used. I made a series of experiments in order to ascertain what was the effect of this objection in practice. In order that there might be no complication from fading, I obtained a series of coloured glasses, cut to fit the tintometer. The spectroscopic composition of glasses can be easily ascertained. I made a numerous series of experiments with red, orange-yellow, pure green, greenish-blue, light purple and dark purple glasses. I matched these glasses at different times of the day, and on different days. I matched them when the sun was shining, and when it was raining or misty. There was a slight variation in the matches on different days, but not so great as I expected. On days which appeared similar in regard to the character of the light there was no appreciable variation. I think that, for practical purposes, this source of error might be disregarded, care being taken that the examinations are made under as nearly as possible similar conditions of light.

The Value of the Standard.

The inventor has employed for a standard a glass very faintly tinted with colour, and all the other glasses of deeper hue are multiples of this standard. For practical purposes the standard is convenient, and within certain limits gives accurate results. An objection to this method of standardising is that a portion of the spectrum having been absorbed by a glass of a given colour, any glass of a deeper shade of this colour must absorb other rays than those absorbed by the first glass. The

combination of a number of glasses of a given hue therefore does not necessarily give rise to a deeper shade of this hue, but may produce a colour of quite a different hue. This may be admirably illustrated with a solution of chloride of chromium. A thin layer of this solution appears green, but a thick layer appears red. On examining the solutions spectroscopically, the reason of this is evident. A thin layer of chloride of chromium is more transparent to the red rays at the extreme left of the spectrum than to any other part, but the predominance of the green rays causes the colour to appear green. When a thicker layer of the solution is used, the green rays, as well as the rays absorbed by the thin layer, are absorbed, and so the colour appears red. With the tintometer glasses the deeper shades of the blue incline to violet, and the deeper shades of the yellow incline to yellow-green. In each case this is more marked if several glasses be used in combination.

Most persons, on looking at the diagrams of the absorption of light by the coloured glasses, and noticing how irregular the curves are, will wonder how it is that the inventor, with one kind of coloured glass, has been able to obtain a series which has a nearly uniform hue. As I have previously stated, the deeper shades of yellow incline to yellow-green, and the deeper shades of blue incline to violet. The change in hue is scarcely noticeable. The rose glass appears of one definite hue throughout.

This is due to the limitation of our colour perception. A spectrum appears to be made up of six definite colours, which pass by innumerable gradations into each other. Therefore it has been concluded that the number of colours is innumerable. This is an illusion, which is heightened by the knowledge that the colours in the spectrum should be practically innumerable in accordance with the wave lengths of the different rays of light. If we examine the spectrum in another way, all colours but the one under observation being excluded, we find that it is apparently made up of a series of monochromatic bands. These monochromatic bands differ in size according to the acuity of colour perception of the observer. A person with acute colour perception sees differences in a band which appears monochromatic to another person. These monochromatic bands, even for a person with the acutest colour perception, are very large in comparison with the units of the physical series, that is, rays of light of a definite wave-length. Here is a spectroscope which I have had constructed for ascertaining the size of these monochromatic bands. If, for instance, a monochromatic band in the green is being looked at, the observer cannot say on which sides the blue and yellow are situated. These monochromatic bands I have designated absolute psychophysical colour units because they form the units of the psychophysical colour series. As we are now only concerned with colour perception in its bearings on the tintometer, I will refer those who wish to pursue the subject further, to my recently published work on "Colour-Blindness and Colour Perception."* If the hues produced by the mixture of red and violet be added to the spectral series, then all known colours will correspond in hue to some point of this series. If we divide this series according to the number of absolute psychophysical colour units seen by a person with normal colour perception, we see that colours may differ considerably, and yet match perfectly, because both are included in an absolute psychophysical unit. It is evident that if we divided a monochromatic patch into a number of different portions, those portions would all match perfectly, though differing in their physical characters.

This fact makes the instrument of much greater utility than would otherwise be the case. The hue of the glasses practically corresponds to one psychophysical unit throughout the series. Though this fact increases the practical value of the instrument, it militates against its use for the scientific registration of colour, when we wish to record, as nearly as possible, the wave-length of the observed colour.

We have also to consider the influence of the other rays which are transmitted by a glass, upon the colour which the glass appears. With three spectral colours, red, green, and violet, we can match all colours: red and green, when combined, form yellow; green and violet make blue. I have already mentioned the fact that white is formed by the union of the complementaries. Therefore the transmission of rays other than those peculiar to the colour of the transmitted light either intensify this colour, or dilute it with white light.

The instrument is one which would be very useful to those who wish to continually reproduce objects of a given hue, as, for instance, manufacturers of colours. Its value,

* "Colour-Blindness and Colour Perception." International Scientific Series. Kegan Paul, Trench & Co., 1891

from a practical point of view, would be considerably increased if glasses were employed which had, as nearly as possible, the same spectroscopic composition as the substance to be matched. For instance, if a red substance is required in a certain manufacture, and it is necessary to have it always of the same hue, then a series of red glasses, having as nearly as possible the same spectroscopic composition as this substance, should be employed. This will, in a great measure, eliminate the source of error produced by the varying spectroscopic composition of daylight. The instrument might also be considerably improved if it were possible to employ a blue glass which was perfectly transparent to the green rays.

I have employed the instrument to estimate the difference in the perception of colour in the two eyes, and it shows admirably how a colour appearing yellow to one eye, may appear yellow-green to the other.

In conclusion, I am of opinion that the instrument is one which affords everyone who is interested in recording colour for some definite practical object, a simple means of doing so. The colours of glasses have a stability which is not possessed by pigmentary colours. It is obvious that the admirable method of matching colours which has been devised by Captain Abney, and is described in his book on "Colour Measurement and Mixture,"* cannot be generally employed for practical purposes on account of the expense of the apparatus and the knowledge required in using it. The tintometer can be used by anyone who has carefully read the instructions given by the inventor. I thank you for your kind attention, and hope that I have succeeded in showing the range of utility possessed by this instrument.

DISCUSSION.

Mr. LOVIBOND called attention to various diagrams on the walls, illustrating his method of working. He said he had worked with light of much lower intensity than had been used by Dr. Edridge Green, and he was not prepared to say whether the question could be treated on the same lines in the two cases. This first step was to endeavour to get a base line to start from, and he tried to get a normal light, but soon had to abandon that idea, for whether daylight or artificial light were used, they varied so much that there was no possibility of getting a starting point. Then it occurred to him that a line of absorption could be obtained by means of glass standards, to which all lights could be referred, and after many years he succeeded in getting glass in three tolerably pure colours, red, yellow, and blue, which were represented on the diagrams, and then the whole system fell into beautiful order. Each colour cut off the complementary rays as shown, and when they were superposed, the red and yellow, by absorbing each other, developed orange; the yellow and blue, by absorbing each other, developed green; and blue and red developed violet; and thus the six principal colours were obtained. He next found that when the three standard colours were combined in equal proportion, a true visual neutral tint was the result with the light of a dull winter day, but in a clear morning or mid-day they let through the excess of orange and red rays, which he believed preponderated in those lights. In that way he believed he arrived at a normal light, viz., the obscure light of a winter day, which could be gradually absorbed by neutral tint degrees in the three standard glasses; but he recently found that a white sea fog was better, being not only normal to these glasses, but also to the spectroscope, though the latter gave one degree higher readings in all the six colours. Having got the six colours, three in glasses, and three normals, made by combination of pairs of glasses, and also a neutral tint from the three standard glasses, he was able to reduce any light to extinction in regular neutral tint degrees; and by reducing any given light in that way you arrived at its base colour, namely, those colour rays which were in excess over the normal light. Sunlight gave red and orange; the blue sky a considerable amount of blue. A curious fact was, that the effect of the glasses on the spectroscopic colours was not the same as when applied to the same rays when mixed as in ordinary daylight; and he believed that in daylight there was a sort of combination of rays analogous to chemical combination which produced a different effect. There was a considerable difference in the power of various colours to withstand a definite quantity of normal light. Taking these six colours in uniform degrees, he was able to make the characters which were exhibited, showing the whole colours of the spectrum divided into two classes, the first red, yellow, and blue, which he called dominants, or standards, being represented by the standard glasses; the others he called "normals," resulting from combinations. Having described the mode of matching and charting colours less pure, as pure, and more pure than the standards, in which latter case he reduced the colour by a neutral tint, not by adding a complementary colour, as Dr. Green described, he said the purity of any colour varied with the light and the substance, and unless there were some fixed light as a standard of comparison, he did not see how the difficulty could be got over. Some of the designs, giving the results of particular experiments, were then described, and illustrated by quantitative sectional areas, showing in their respective colours the proportion of colour-rays of absorbed and unabsorbed light, which together make

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* "Colour Measurement and Mixture," by Captain W. de W. Abney, F.R.S., published by the Society for Promoting Christian Knowledge, Northumberland-avenue, W.C.

up the whole beam reflected from various substances, as, for instance, two ultramarines, one pure, the other artificial; different shades of black and white; the exact colour of the various London daily papers; and the colour of various samples of water. Distilled water contained only a little green and yellow; from a chalk well, yellow, green, and blue, and, on filtering, it lost green and blue, and became yellow. Water from the river Aire was nearly black. With reference to the apparent failure of the glasses to do their duty in cutting out the complementary colours in the spectrum, as they did in daylight, when the rays were brought together in daylight, he believed they combined and acted differently on the glass to what they did when they were taken separately, as in the spectrum. This could be shown by building up white light with isolated coloured rays; that is, with colour rays entirely separated from the excess of light, and overlapping adjacent rays in the crowded end of the spectrum, which appear to be inseparable in experiments made with the spectrum produced by the prismatic spectroscope.

Mr. SEBASTIAN DAVIS said there was a peculiar tint found in water which had been treated by Clark's process, in which a quantity of lime was added to remove the carbonic anhydride, and then precipitated. After that a peculiar blue tint was obtained. This could be well seen at Joynson's Paper Mills, at Dartford, where the system was used. Perhaps Mr. Lovibond could explain how that arose.

Mr. LOVIBOND said he had not experimented on that water.

Captain ABNEY said Mr. Lovibond had perfected this admirable instrument in a manner which not only reflected the greatest credit on him, but showed the scientific character of his mind, though, as he understood, he had not had a scientific training. It was quite true he believed, as stated in the paper, that if you had two or three glasses together you could tell the character of the light by deducting the absorption of each glass from white light, and mixing the remainder; but in order to do that, it was necessary on this plan, that each individual glass should be measured, which would be a work of no small labour. Mr. Lovibond had taken as his standard the minumum colour, and his contention was that for scientific purposes it was rather the maximum which ought to be standardised—for this reason. If you put twelve No. 16 glasses together, though he was quite sure they would not differ appreciably, and if you had the total absorption, you could easily calculate that of each one; but when you came to take the absorption spectrum of a faint colour, the errors you might make were so enormous that, when multiplied by twelve, they would make the readings untrustworthy. A great many yellow glasses together gave orange, and from several blue glasses you got a very different colour from that of a light-tinted glass. On what system, therefore, was it suggested that the absorption spectrum should be deducted from white light so as to get a scientific measurement of colours? Dr. Edridge-Green said two colours which differed considerably in wave length might yet match perfectly, because they were both included in one psychophysical unit. It might be a matter of opinion or of experiment, but he certainly could not accept that statement, which seemed to him erroneous because he personally could distinguish any slight variation in the colour of the spectrum which lay, he thought, well within the physophysical unit as defined. He could see plainly that one part of the green patch shown on the screen was yellower than the other. With the instrument which he had shown there on more than one occasion, the minutest difference in the position of the slit placed in the spectrum could be detected. If you could divide the spectrum into 100 parts you could tell each one from the other. In looking at a rather impure spectrum, at first glance, he only saw three colours—red, green, and violet; and when he came to examine it, he found an infinity of colours. He therefore could not endorse the statement that you could not distinguish one colour from another if they were situated close together, and his opinion was founded on experiments which numbered thousands, and had been going on many years. As to the glasses, he had already said that this instrument was very valuable, but he could not sanction Mr. Lovibond's heresy that there was any combination of rays in one kind of light more than in another. The great thing to aim at was to have a material perfectly free from banded absorption, which for scientific purposes was a great drawback. The blue glass appeared to be cobalt, but there were other blues which were free from those bands of absorption in the red end; and for scientific purposes it would be preferable to use a glass having general absorption rather than one with a banded absorption. The normal light from white fog was very interesting. The search for a normal or standard light had gone on for some years, but for his own purposes, and for scientific work, he found nothing to equal the crater of the positive pole or the electric arc. It was always a uniform temperature, and was always equally white, which could be proved thus:—Take a shortish spectrum, and put in two slits, one in the green, and the other in the violet; mix the two lights together in such proportion as to form white, and you might watch alongside of it the white light undecomposed. Put any carbons you liked into the lamp, there would be no variation, showing that the proportion of green to violet was the same in both. To that standard all lights and all colours might be referred. He was surprised to hear that distilled water was yellow and green. A few years ago, he investigated the absorption spectra of colourless fluids in the ultra red by means of photography, which had no personal bias, and registered its own results, so that there could be no mistake, and distilled water he found anything but yellow. He had a tube 6 feet long,

and no ultra red light passed, very little red, slight yellow, and plenty of blue; so that distilled water in its purest form certainly had a blue tint. He did not throw any doubt on Mr. Lovibond's observations, but on the purity of the water he used. The water from the gravel well seemed to bear out the conclusion that pure water would be a blue colour.

Mr. LOVIBOND said there might be impurities in the standard glasses. Even supposing that the impurities were not self-correcting, he did not think they could be so great as to create the difference between the two sets of observatious. The water he used was carefully distilled from glass, but you could make such water look any colour you liked, by illuminating it with light of that colour. If you looked at it with light from a blue sky, you had a beautiful blue colour, while, in the morning's light, you get a reddish tinge; in fact, the visual colour changed with the light, whilst the measured colour remained constant. There was always a danger of mixing up the measurement of the object with the light it was viewed by. That was why he did not like to rely on measurements made by intense light. No definite statements of visual impressions could be made unless the light employed was quoted.

Dr. THORNE said he had used this instrument for some time in his laboratory for estimating the colours of oils, glass, and so on, and found it very useful for registration and comparison. It gave results which were not to be obtained by any of the easily utilisable forms of colorimeters. From a scientific point of view, as Captain Abney had said, an intense colour would be the best unit, but for ordinary purposes it was necessary to deal almost entirely with low tint colours.

Dr. EDRIDGE-GREEN, in reply, said Captain Abney had answered the objection raised by Mr. Lovibond with regard to the light, and he need only add that it was desirable to choose lights as nearly as possible of the same character. The method he had described, of measuring the absorption curve, was the same as that employed by Captain Abney. For the yellow, he took about twenty-two glasses, which gave the highest point, 207°. One could go on adding glasses until all the light was excluded, and thus get a complete curve. It would be very difficult to measure with the spectroscope faintly tinted glasses. With regard to the psychophysical units, the patch on the screen was only approximately monochromatic, but in looking at a pure spectrum, he could see a very large portion which appeared absolutely monochromatic, as did the patches Captain Abney had showed him, which contained a large number of wave lengths. He had not succeeded in seeing any more colours in a magnified spectrum than in one produced by a good spectroscope. He therefore ascribed this limitation to a limitation in perception, and he found this to differ in different persons. Some could see very minute deficiences, but even then they saw a unit which corresponded to a large number of wave lengths.

Captain ABNEY said with his instrument you could make the slit as fine as you liked, for instance, as the difference between the two D lines. The spectrum could be made as pure as you liked by closing first the slit of the collinator, and, secondly, the slit in the spectroscope. If you had a spectrum of 5-in. length, and made the slit ·01 in., it would not be difficult to calculate within what difference of wave length you got a different colour.

Dr. EDRIDGE-GREEN asked if Captain Abney could distinguish a difference of colour between the two D lines. To him they were absolutely monochromatic.

Captain ABNEY said the only way to compare two colours was to put them side by side in a patch, and he had never done that with the light of the two D lines. You might call a line any colour you liked almost when dim; there must be a certain area, or you could not distinguish it. You would not see any yellow in the sky through a pocket spectroscope, because your vision was confined, but directly you took a large spectroscope and pointed it in the same direction, the yellow appeared. It was a question of size as much as anything else.

Dr. EDRIDGE-GREEN admitted that entirely, but said different persons had different perceptive powers, one would see yellow where another would not. In the case mentioned where the yellow was not seen, the observer was reduced to a condition of imperfect perception; in other words, he saw as if he were partially colour-blind. Orange was the first to go; then blue then yellow, then green. He did not think a normal-sighted person could succeed in reducing his perception below the three primary points of difference—red, violet and green; but by reducing the light you could cause yellow, or blue, or orange to disappear. However you magnified the spectrum, you saw no more colours, and no less. With defective light you might see five, four, or three, instead of six. He had never succeeded in seeing the seven which Newton described; but there were a few persons who did, and they described them exactly as Newton did. It was only in that sense he used the term psycho-physical units.

The CHAIRMAN, in proposing a vote of thanks to Dr. Edridge-Green, said the deep blue colour of water treated by Clark's process could be very well seen near Caterham, in the tanks of a local water company, where this process was adopted. It had always appeared to him to be analogous to the blue of the sky, and to be due to the same cause, namely, the presence of very fine particles, arising from the precipitation process, which had not sunk to the bottom.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

FOREIGN COUNTRIES AT THE CHICAGO EXHIBITION.

A memorandum lately issued by the Chicago Executive gives the following list of foreign countries which have accepted, with the amounts voted, where these are known:—

	Dollars.		Dollars.
Argentine Republic	100,000	Great Britain—	
Austria	149,100	Trinidad	15,000
Belgium		Victoria	
Bolivia	100,000	West Australia	
Brazil	600,000	Guatemala	120,000
China		Hawaii	
Chili	100,000	Hayti	
Colombia	100,000	Honduras	20,000
Costa Rica	100,000	Italy (informal)	
Denmark		Erythria	
Danish West Indies		Japan	630,760
Ecuador	125,000	Korea	
Egypt (informal)		Madagascar	
France	400,000	Mexico	750,000
Algeria		Netherlands (informal)	
Germany	215,200	Dutch Guiana	10,000
Great Britain	125,000	Dutch West Indies	5,000
Barbadoes	6,000	Nicaragua	30,000
British Columbia		Orange Free State	
British Guiana	25,000	Paraguay	25,000
British Honduras	7,500	Persia	
Cape Colony	25,000	Peru	125,000
Ceylon	40,000	Russia	
India		Salvador	12,000
Jamaica	20,000	San Domingo	
Malta		Siam	
Mashonaland		Spain	
New South Wales		Cuba	25,000
New Zealand		Transvaal	
Queensland		Turkey	
South Australia		Uruguay	
Tasmania		Venezuela	
		Total	$4,004,560
		or say	£800,000

Herr Wermuth, the German Imperial Commissioner to the Exposition, has sent word that the 100,000 square feet reserved for Germany in the Manufactures Building has already been taken, and that much more space could be utilised by German manufacturers if it can be obtained.

A Reuter's telegram states that Mr. Davis, the Director-General of the Exposition, has received from M. Antonin Proust, Director of the Fine Arts Section of the World's Fair Commission of France, an application for 82,000 square feet of wall space in the Art Building, and this amount, large as it is, will probably be granted. England and Germany have each asked for, and been allotted, 20,000 square feet (of floor space, probably equivalent to 25,000 square feet of wall space), while Belgium has secured 8,000, Holland and Denmark 3,000 each, and Japan 2,000 square feet. According to the architect who designed the structure, the Art Building and annexes will contain 250,000 square feet of floor and a mile of wall space, so that it will doubtless be found possible to meet all demands.

NUTMEG CULTIVATION IN JAMAICA.

In the *Bulletin of the Botanical Department of Jamaica* for October last it is stated that a large stock of the very finest nutmegs for seed has been imported to Jamaica from Grenada, and has been sown in the Hope Gardens, and, when ready for distribution, will be sold at the very low rate of three halfpence each, in large or small quantities. It is hoped that these arrangements will tend to develop the planting of nutmegs on a large scale in suitable districts in Jamaica. It is stated that already one order has been filed for 10,000 plants, and another for 5,000. The germination of the seed in large quantities, and the care of the seedlings, is said to require the strictest attention, to prevent extensive loss. From the seed beds, the seedlings are transferred to bamboo pots, and, when they have quite recovered from the transplanting, and have formed good roots, they are ready for the nutmeg plantation. The planters must now exercise strict supervision over the labourers, to see that the bamboo pot is carefully slit down on one side, and the plant, with the earth undisturbed round the root, gently placed in the hole prepared for its reception. If this operation is done too harshly or clumsily, the tip of the tap root is broken, and the plant soon dies.

Nutmeg trees require a deep, rich, loamy soil, moist, but not swampy, with a humid atmosphere. They thrive best in steady river valleys from sea-level up to 300 or 400 feet, but they will grow in favourable situations up to an elevation of 2,000 feet. The trees should be placed at distances of 25 or 30 feet apart, and if the situation is not naturally shady and sheltered, trees should be planted for the purpose of breaking the wind as well as for shade. The trees are a long time coming to maturity, not producing a crop, as a rule, till they are nine years old; and only when they first flower, at six or seven years of age, is it possible to determine whether they are male or female. A very small proportion of male trees is left for fertilisation by insects; the rest are cut down, and fresh plants are substituted. The fertile trees continue to produce fruit for seventy or eighty years. On an average, each tree will yield ten pounds of nutmegs and about one pound of mace every year, and, when highly manured, it is said that they will produce ten times that amount.

In connection with the same subject, a note on the curing of nutmegs in Grenada is given in the November number of the *Jamaica Bulletin*, the details of which may be of service to those who are starting the culture. The process is said to be that which is adopted for preparing the nutmegs for the London market. The nutmegs are picked up from under the trees every day, except Sunday. On being brought into the boucan, the mace is peeled off and pressed flat between heavy blocks of wood, where it is left for two or three days, then put into a case and left, till it reaches the proper colour. The nutmegs are put into receptacles (with fine mesh bottoms, so that the air can pass through) inside the boucan, and left there for three weeks or a month, in fact until the nut begins to shake inside the shell. They are then shown the sun for a couple of hours a day for two or three days. After this they are cracked. Great care is necessary here, for if the outside shell is struck too hard it makes a black spot in the nutmeg, which affects the value considerably. When cracked the nuts are sorted according to size, put into ordinary flour barrels and shipped. Regarding the value of the produce of nutmeg trees, when in full bearing, it is stated that one grower in 1883 realised from two trees as much as £30.

Obituary.

DR. ALFRED CARPENTER.—Dr. Carpenter, an active member of the Society since 1876, has just died at Ventnor. He was born in 1825, educated at Moulton Grammar School, Lincolnshire, and studied medicine first at Northampton Infirmary, and afterwards at St. Thomas's Hospital. He commenced practice at Croydon in 1852, and was a particularly energetic member of the Croydon Board of Health. He was elected President of the Council of the British Medical Association in 1879, and was for many years a Justice of the Peace for Surrey. Dr. Carpenter read several papers before the Society of Arts, and was a frequent attendant and speaker at meetings on sanitary subjects. The last paper read by Dr. Carpenter before the Society was on the "Utilisation of Town Sewage by Irrigation," on February 2nd, 1887.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

FEBRUARY 3. — T. PRIDGIN TEALE, M.A., F.R.C.S., F.R.S., "Dust, and How to Shut it Out." Prof. T. E. THORPE, Ph.D. F.R.S., will preside.

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

FEBRUARY 17.—Capt. F. E. YOUNGHUSBAND, "The Pamirs."

FEBRUARY 24.—Mr. ERNEST HART, "Ancient and Modern Art Pottery of Japan." Prof. WILLIAM ANDERSON, F.R.C.S., will preside.

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

Papers, the dates of reading of which are not yet fixed :—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given :—

FEBRUARY 16.—LEWIS ATKINSON, "The Forthcoming Exhibition at Kimberley." 8 p.m. The paper will be illustrated by lantern slides.

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru." 8 p.m.

APRIL 5.—The Rev. JOHN MCLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19. — JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets." Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., will preside.

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

LECTURE II. — FEBRUARY 1. — High-pressure supply—Old attempts—Alternate currents—Transformers — Feeders — Sub-stations — Overhead and underground conductors—Generation of electricity by power obtained at a distance from (1) electricity, (2) gas, (3) compressed air, (4) water under pressure—Load factor—Waste products.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. George Forbes, "Developments of Electrical Distribution." (Lecture II.)

Farmer's Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Rew, "The Migration of Farm Labourers to the Towns."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town Hall, 7½ p.m. Inaugural Address by the President (Mr. J. W. Wilson, jun.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Messrs. Wanklyn and Johnstone, "Oxidation of the Fatty Acids." 2. Mr. Watson Smith, "The Stability of Certain Organic Nitrogen Compounds occuring in Coal-Tar Pitch."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the paper by Mr. E. H. Morris, "The Four-Course System, with Desirable Variations."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1 A, Adelphi-terrace, W.C., 8 p.m. 1. Mr. J. W. Slater, "Natural Selection." 2. Mr. J. J. Murphy, "Reality of Knowledge." 3. Capt. F. Petrie, "Brief Notes on a recent Submarine Volcano."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Louis Fagan, "Line Engraving—English School."

TUESDAY, FEB. 2 ... Royal Institution, Albemarle-street, W., 3 p.m. Professor Victor Horsley, "The Brain." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Alfred Harper Curtis, "Gold-Quartz Reduction."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W, 8½ p.m.

WEDNESDAY, FEB. 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. Pridgin Teale, "Dust, and How to Shut it Out."

Entomological, 11, Chandos-street, W., 7 p.m.

Archælogical Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W. 8 p.m. Annual Meeting.

Civil and Mechanical Engineers, Westminster-palace Hotel, S.W., 7 p.m. Mr. J. F. Reade, "Main Drainage Extension in Towns."

Electrical Engineers, in the Theatre of the Royal Institution, Albemarle-street, W., 8 p.m. Mr. Nikola Tesla, "Experiments with Alternate Current of High Potential and High Frequency."

THURSDAY, FEB. 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. N. Williams, "A Monograph of the Dianthus." 2. Dr. G. Jeunings Hinde and Mr. W. Murton Holmes, "The Sponge Remains in the Lower Tertiary Strata, near Oamaru, Otago, New Zealand."

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Percy Fitzgerald, "Recollections of Charles Dickens."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. S. Murray, "Some Aspects of Greek Sculpture in Relief." (Lecture III.)

Historical, 11, Chandos-street, W., 8½ p.m. Mr. O. Browning, "The Evolution of the Family."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Mr. Joseph Parry, "Notes on Mechanical Features of the Liverpool Water Works, and on the supply of Power by Pressure from the Public Mains, and by other means."

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, FEB. 5...United Service Institution, Whitehall-yard, 3 p.m. Lieut. H. B. Jones, "Military Ballooning."

Royal Institution, Albemarle-street, W.. 8 p.m. Weekly Meeting, 9 p.m. Prof. W. C. Roberts-Austen, "Metals at High Temperature."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Mr. William Hawdon, "The Disposal and Utilisation of Blast-Furnace Slag."

Geologists' Association, University College, W.C., 8 p.m. Address by the President, "The Evolution and Classification of the Cephalopoda: an account of recent advances."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. G. F. FitzGerald, "The Driving of Electro-Magnetic Vibrations by Electro-Magnetic and Electro-Static Engines." 2. Prof. S. P. Thompson, "Supplementary Colours."

SATURDAY, FEB. 6...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. A. Fleming, "The Induction Coil and Alternate Current Transformer." (Lecture III.)

Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Capt. W. de W. Abney, "Colour Blindness."

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FRIDAY, FEBRUARY 5, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The second lecture of the course, on "Developments of Electrical Distribution," was delivered by Prof. George Forbes, F.R.S., on Monday evening, 1st inst. The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

The publication of Mr. William Morris's paper, on "The Woodcuts of Gothic Books," is unavoidably postponed until next week, when it will be printed in the *Journal.*

Chicago Exhibition, 1893.

A meeting of the Royal Commission was held on Wednesday, 3rd inst. Present: The Attorney-General, M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Francis Cobb, Prof. James Dewar, M.A., F.R.S., Major-Gen. J. F. D. Donnelly, C.B., James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. Malcom Kennedy, C.B., Alexander B. W. Kennedy, F.R.S., John Biddulph Martin, J. F. Moulton, Q.C., F.R.S., W. H. Preece, F.R.S., Prof. W. C. Roberts-Austen, C.B., with Sir Henry Trueman Wood as Secretary.

COMMITTEE ON AGRICULTURE.

A meeting of the Agriculture and Food Products Committee was held on Monday, 1st inst., at 12, Hanover-square. Present: The Earl of Feversham, President of the Royal Agricultural Society, in the chair; Earl Cathcart, G. Allender, Sir Edward Birkbeck, Bart., M.P., J. Bowen-Jones, W. Burdett-Coutts, M.P., Alfred Darby, Colonel Sir Nigel Kingscote, Lieut.-General Michael, C.S.I., Ralph Palmer, Albert Pell, Daniel Pidgeon, John Thornton, Dr. J. A. Voelcker, Sir William Williams, Christopher W. Wilson, with Sir Henry Trueman Wood, Secretary of the Royal Commission, and Ernest Clarke (Honorary Secretary).

COMMISSION FOR NEW SOUTH WALES.

The New South Wales Government has appointed a Commission for the Chicago Exhibition, of which Mr. William McMillan is President, and Dr. A. Renwick, Executive Commissioner. It is estimated that the cost of the Commission will be £30,000.

REPORT ON THE PRESENT CONDITION AND PROSPECTS OF THE CHICAGO EXHIBITION.

By Colonel J. Hayes Sadler,
H.M. Consul at Chicago.

The following Report (dated 13th January) on the progress made in the constructions and arrangements for the World's Columbian Exposition, to be held at Chicago in 1893, has been received by the Secretary of the Royal Commission from the Secretary of State for Foreign Affairs :—

Introduction.

Anyone who now visits the site of the proposed Chicago Exhibition, and saw its condition when first ground was broken on the 27th January last year, must marvel at the progress which has been made in this vast undertaking, and at the rapidity with which the plans have taken shape. No reasonable doubt can now be entertained that the constructions and arrangements on the ground will be completed, and that everything will be ready within the required time. But it is not only in Jackson-park that great progress has been made. The organisation of the executive machinery, and preliminary plans and

arrangements, which entailed a vast amount of labour, are complete, and working well and smoothly; and it may be fairly said that all the necessary details have been decided or considered; that such matters as may further arise are ready to be met; and that the preparations for the largest Exhibition ever held are perfected. The energy and determination, the liberality and fairness shown in the management of the enterprise, both by the National Direction and the Local Commission, are proofs of the executive talent selected to preside over the different departments, on which such an enormous amount of work has been thrown.

The progress made in the constructions and arrangements will be seen under the following heads :—

1. Introduction.
2. The Site.
3. Financial position.
4. The Main Buildings.
5. Cost and progress of Exposition Buildings.
6. Other Works.
7. Government and State Buildings.
8. Foreign Countries.
9. Transportation.
10. Insurance.
11. General Regulations.
12. World's Congress Auxiliary.
13. Other attractions.
14. Prospects and advantages of exhibits.
15. Dedication and Opening.

The Site.

When first this city was selected for the World's Columbian Exposition, the difficulties to be encountered by the Chicago Commission were great and numerous; the fixing on the site, which was a peculiarly embarassing matter, was the subject of long discussions; many conflicting opinions and interests were brought to bear before a decision could be arrived at; but the one broad view of consulting solely the interest of the Exhibition was adhered to, and there appears to be no other opinion than that no better site could be chosen than the one selected, and it is generally admitted to be perfect. Situated for the length of a mile and a half on the borders of Lake Michigan, which has all the appearance of a sea, Jackson-park, though seven miles from the centre of the city, affords the great advantage of space; it has an area of 586 acres, besides which there are the 80 acres of the Midway Plaisance, an unoccupied piece of ground adjoining it on the west and leading to the neighbouring South-park, which affords a further space, if necessary, of 371 acres. It affords another great advantage over all former Exhibitions of a similar character, that of water.

With the exception of a small portion on the northern side, the whole of Jackson-park a year ago was a swamp, a combination of marsh, water, and hummocks, and a vast amount of labour, time, and expense was required in laying out the ground preparatory to the foundations being laid of the proposed buildings. The borders of the lake have already been converted from a sandy beach into a stope of stonework, capped by a magnificent esplanade of white concrete; the grounds are laid out in broad terraces, basins, lagoons, and canals, separating and in great part surrounding many of the principal buildings now in course of construction, and as soon as these buildings are finished plans are ready for finally beautifying the grounds, and setting out beds of flowers. Many trees have been already planted, and several thousand plants are in the propagating houses. The buildings are of great size and architectural beauty, and with the distribution of water, the grounds will provide a scene of unequalled beauty.

Financial Position.

Cost.—The cost of the buildings constructed by the World's Fair Commission, which do not include such as may be built by the United States Government, the various States of the Union and foreign countries, or other constructions for which concessions may be granted, will amount to about £1,600,000,* and besides this sum there are other sums estimated as follows :—

	£
Grading, filling, &c.	90,080
Landscape gardening	64,680
Viaducts and bridges	25,000
Piers	14,000
Waterway improvements	45,000
Railways	100,000
Steam plant	160,000
Electricity	300,000
Statuary on buildings	20,000
Vases, lamps, and posts	10,000
Seating	1,600
Water supply, sewerage, &c	120,000
Improvement of lake front	40,000
World's congress auxiliary	40,000

* For the convenience of this Report, exchange is calculated at the rate of 5 dollars per £1 sterling.

	£
Construction department, expenses, fuel, &c.	104,000
Organisation and administration	661,713
Operating expenses during Exposition	310,000
	£2,106,091

Making a total of £3,706,091, as the cost of the Commission, to meet which the following is a statement of resources:—

	£
Stock subscriptions	1,144,246
City of Chicago bonds	1,000,000
Prospective gate receipts	2,000,000
Concessions and privileges	300,000
Salvage	6,600
	4,750,846
To which may be added future subscriptions and interest on deposits estimated at	40,000
Total..	£4,790,846

As the gate receipts will not come in till the Exhibition is open, and payments on the contracts must be met, it is proposed to ask a loan of £1,000,000 from the United States Government, which it is believed will be shortly laid before Congress. The charge on entrance to the grounds will probably be fixed at two shillings.

The Main Buildings.

The great buildings, constructed at the charge of the Commission, are distributed in the centre and southern part of the park, the northern part of which is set aside for the constructions of foreign countries and the separate States of the Union. They cover 153·8 acres, and, with the gallery area, will have a total floor space of 199·7 acres. The most eminent architects in the country have contributed to the plans, and every endeavour has been made that the enterprise shall have a thoroughly national, and not solely a local, character. The architecture is greatly Corinthian, and promises, in an artistic point of view, to be eminently successful; at the same time the lagoons and canals will give a Venetian effect, and reflecting the numerous palaces and the powerful electric lights will produce a magical appearance at night. The framework of the Exposition buildings, which are designed for temporary use and for removal, is of iron or steel sheathed with wood, and coated inside and outside with staff. This latter material is composed of clay, plaster of Paris, glue and hair, and is fire-proof and impervious to water. It is moulded in sheets, of various and elaborate designs, and affixed to the wooden sheathing; tinted in imitation of different stone and marble, it gives all the effect of sculptured masonry. The masonry of the lagoons and statuary will also be of this material. The advance made of late at Chicago in the use of iron and steel columns, girders, and joists, as a framework, with a mere facing of tile or brick, has enabled large constructions to be erected with a rapidity before unknown, and they have all the appearance of having taken years to build. The erection of the framework occupies nearly three-fourths of the time required to complete the building. The progress in construction has been marvellous for so short a time, the foundations have all been finished, many of the buildings have assumed a form which gives an idea of their grandeur, and one is exteriorly complete. The weather up to the end of the year was not unfavourable, and allowed of almost uninterrupted work. In December alone, 3,433,453 lbs. of iron and steel were brought to the ground, 5,306 car loads of material were delivered, 10,000,000 feet of lumber were consumed, and 1,446,200 lbs. of iron work were placed. The quantity of lumber required altogether for the buildings is 60,000,000 feet, and of iron and steel about 18,000 tons. The total quantity of staff required will be 84,000 pieces, of which 23,500 were cast up to the 1st January. The daily average of labourers employed in December was 2,824, besides 800 *employés*. Work has been proceeding day and night, by relays of labourers, as the agreement with the labour unions was that a day's labour should be eight hours.

Size, Cost, and Progress of the Exposition Buildings.

Administration. — The Administration Building has a dimension of 262 by 262 feet, covers 1·6 acres, and costs £87,000. With its gilt dome, it will perhaps be the most striking object in the grounds. It consists of a large rotunda 120 feet in diameter, and 220 feet in height, surrounded by a colonnade and four pavilions. The structure work of the latter and the exterior covering are finished. The ironwork of the rotunda is placed to the level of 170 feet, from which height the dome will spring. The pavilions, four stories high, will contain the offices and board-rooms of the different departments of the Administration, besides the fire and police departments, the

ambulance service, physician and pharmacy bureau, the bank, police-office, and other offices. Nearly £9,000 have already been paid on the contract.

Manufactures and Liberal Arts.—The Manufactures and Liberal Arts Building measures 1,687 feet by 787 feet, costs £300,000, and covers 30·5 acres. As yet £29,000 have been paid for work done. The 30·5 acres of floor are laid, and the superstructure is gradually showing above it. The huge steel trusses for the roof will shortly be raised. It will be the largest building ever constructed for exhibition purposes, and with its strictly Corinthian style, and the staff covering tinted to represent marble, will have a fine architectural effect. The central hall will have a clear space nearly a quarter of a mile long by 127 yards wide, and a height of 200 feet. As originally designed, there was an open court at each end, but these are to be roofed, to give more room, at an additional cost of £40,000, and, with the galleries, the building will have a floor space of 40 acres.

Mines.—The Hall of Mines and Mining is 700 by 350 feet, covers 5·6 acres, and is contracted for at the price of £53,000, of which £27,000 has been paid. This construction is far advanced; the framework and wood covering is completed, and finishing touches are being put on the iron and glass roof. The staff covering is being applied, and will be continued during the cold weather, as will be the case with all buildings ready to be covered, by erecting against the wall a moveable shed heated with a stove.

Electricity.—The floor of the Electricity Building has been laid some time, but further progress was stopped for the purpose of strengthening the foundations so as to enable them to bear the weight of the machines, which will be heavier than was anticipated. A large staff of men have however been employed during the last four or five weeks, and the framework is completed up to the gallery floor, and nearly all the great steel trusses for the roof are in place. The size of the building is 690 by 345 feet, the area 5·5 acres, and the cost £80,200. £17,500 have been paid on this contract.

Transportation. — Four months ago the Transportation Building had not been commenced, the site was an irregular sand heap, and the timber for construction was not on the ground. The framework is now practically completed as well as the roof sheathing over the galleries; the clerestory trusses are being raised, and when the glazing and putting on the staff is done it will be ready for occupancy. The main building is 960 by 256 feet, with an area of 5·6 acres, and the annex 900 by 425 feet, with an area of 8·8 acres, and the total cost is £74,000, of which £30,000 have been paid for work finished. This building will contain every description of exhibit devoted to the purpose of transportation. Immense freight sheds have been erected.

The Woman's Building is the nearest towards completion of all the constructions, the scaffolding being removed, and exteriorly, with the exception of the windows, it has assumed the appearance of a finished marble palace. The finishing of the interior is progressing. It measures 388 × 192 feet, and has an area of 1·8 acres, costing £27,600, of which £14,000 have been paid.

Art Galleries.—The Art Palace is built of brick, and has an area of 3·7 acres, being 500 × 320 feet; besides which there are two annexes, each 200 × 120 feet, giving an additional area of 1·1 acre, the whole costing £134,000, of which between £5,000 and £6,000 have been paid. The basement and floor are completed, and the brick walls have reached an average height of 10 feet above the second floor. More than five million bricks have been laid already. Space in this building has been applied for by several foreign nations. The Fine Arts Building has a total wall space of 145,852 square feet.

The present idea is that this building will be retained where it is as a permanent art gallery, as a survival of the Exposition, and that paintings will be gradually purchased for it.

Fisheries.—Two months ago the Fisheries Building was represented by a heap of lumber and a sawmill. The iron framework of the aquaria is now complete, the gallery trusses of the main building are placed, and the western pavilion is showing above the ground. The extreme length of the main building is 365 feet, covering an area of 1·4 acres; a curved corridor on each side connects it with two circular wings or pavilions 135 feet in diameter, one for the aquaria and the other for angling exhibits, giving a total length of 1,100 feet. The structure will cost £44,200, and £5,200 have been paid for carpentry and plaster model work done.

Horticulture.—The Horticultural Building is 998 feet long by 250 feet broad, and consists of a central domed pavilion and two side pavilions, joined by curtains forming interior

courts, and covers 5·7 acres. The cost is £60,000, of which £10,000 have been paid for carpentry and modelling done. There will, besides, be eight greenhouses, 100 × 24 feet, covering half an acre, and costing £5,000. The pavilions are constructed up to the roof line; the west curtain is complete as far as the woodwork is concerned; the roof is glazed, and windows are being placed; lack of iron has delayed the construction of the dome, but the ironwork is now being put in position.

Machinery.—The Machinery Building is the most expensive of all the constructions, costing £240,000, but as yet only £3,000 has been paid for work done. The dimensions of the main building are 846 by 492 feet, with an area of 9·6 acres, and those of the annex 550 by 490 feet, having an area of 6·2 acres. The floor of the main hall is laid, and 6,000 supporting pillars are erected, and the foundation of the annex is being laid. The whole length of the construction is 1,400 feet, and the architectural effect of the main hall will be very fine. There will be also annexed a power-house, pumping works, and machine shop, covering 2·1 acres, at an additional cost of £17,000.

Agriculture.—The main Agricultural Building is 800 feet long by 500 wide, and covers 9·2 acres; the annex is 560 by 300 feet, with an area of 3·8 acres, and together they will cost £123,600, besides which there will be an Assembly Hall, &c.; 400 by 120 feet, which will cost £20,000. £18,500 have been already expended for carpentry and modelling work. The interior columns and gallery girders and joists are in position, and the iron columns to support the roof are being placed; numbers of workmen are engaged in erecting the woodwork, which to the extent of 7,000,000 feet of lumber is already sawn for the construction, and more than half is already placed.

Saw-mill.—At the back of the Agricultural Annex is a saw-mill 300 by 125 feet, having an area of an acre, and costing £7,000.

Forestry.—The forestry building is situated in the south-eastern part of the park, and costs £20,000; it has an area of 2·5 acres, being 528 by 208 feet. It is about three parts finished, and will be occupied by the model makers till the spring, when the rustic work will be put on, and the temporary roof replaced by a thatched one.

Dairy.—The Dairy Building lies just beyond the Forestry, measures 200 by 100 feet, with an area of half an acre, and will cost about £6,000. All the columns are up to the roof line, and the gallery floor is being laid.

Live Stock.—The Live Stock Buildings, pavilion, and sheds will cover 43·7 acres, the ground given up to that department being altogether 63 acres, and the cost of construction will be £67,000.

Pier and Casino.—A pier 80 feet wide runs out from the north-east corner of the architectural building, stretches 1,200 feet into the lake, and at right angles to the extremity run two shorter piers, forming a harbour, inside the northernmost of which, facing the basin and Administration Building, is situated the Casino, of Venetian architecture, built on piles, the seven separate pavilions of which are intersected by water. The Casino is 250 by 120 feet, and, with the Music-hall, will cost £42,000.

Other Works.

Besides the main buildings a great deal of other work has been done towards carrying out the plans adopted by the Grounds and Buildings Committee.

Woter Supply.—To supply the buildings and grounds with water two plants are to be put in with a capacity, one of 24,000,000 gallons a day, the other 40,000,000, making a total of 64,000,000 gallons a day. The machinery will shortly be installed.

Drainage.—A system of drainage and sewerage has been adopted, which is believed to be adequate and perfect. The work is progressing fast. All refuse will be received by injectors and forced by compressed air through underground pipes into four huge tanks, where it will be treated chemically and rendered inoffensive.

Lighting.—The plans for lighting are also being actively carried out. The electric plant will require 22,000 horse-power, and the plans are adopted for providing 138,218 lamps, of which 6·766 will be arc lamps of 2,000 candle-power each, and 131,452 incandescent lamps of 16 candle-power each. The effect of the electric lighting will be greater than has ever yet been produced. An immense railway station is being laid out to the west of the Administration Building, in conjunction with the railway system and bridges and viaducts are in course of construction.

Bazaar.—The Midway Plaisance is set apart for the bazaar of all nations, and contracts have already been entered in this space for a typical Egyptian street, and a section of Constantinople, to cost together £300,000; a

German village, Moorish palace, a Maori village, and other constructions of a similar character, for which concessions have been granted. An additional charge will be made for visiting this part, which will be outside the Exposition proper.

Government and States Buildings.

The United States Government appropriated £300,000 for the World's Columbian Exposition, of which sum £80,000 was set aside for building, and a great portion of the remainder has been spent in National Committee expenses and preparations for Government exhibits. It is expected that a further appropriation will be made, the cost of awards (£140,000), the awarding juries, and further National Commission expenses. The Government Building measures 415 feet by 345 feet, covers 3·3 acres, and costs £80,000. Work is rapidly being pushed on. The imitation battle-ship, also constructed by the National Government, is built of brick, in the lake, a short distance from the shore, and is completed to the deck level. It is 348 by 69·25 feet, and costs £20,000.

Twenty-six States and territories have already made varying appropriations for their separate State representations, amounting in the aggregate to £539,000. This sum will be largely increased, as, in many cases, the vote is only preliminary; in some, money is being raised by subscriptions for further representation, and the legislatures of other States have yet to fix upon the sum they intend to appropriate. In the State of New York it is said a proposal will be submitted for an appropriation of £300,000. Plans for the buildings of some of the States have been approved, but their construction has not yet been commenced, except in the case of Illinois State Building, which is progressing rapidly, and, with its two wings, will cover 2 acres, and cost £50,000. All the States buildings will be clustered together at the northern part of the park, in the neighbourhood of the ground reserved for foreign countries. It is expected that the separate expenditure of the several States and Territories will exceed £1,000,000, 44 States and 5 Territories having signified intention to participate.

Foreign Countries.

Thirty-nine foreign nations and 24 colonies have signified to the Direction their intention of participating in the Exhibition. Their names, and the amount of their appropriations, made or proposed—as far as yet known—are as follows:—

Country.	Appropriation.
Argentine Republic	£20,000
Austria	29,850
Belgium	
Bolivia	20,000
Brazil	120,000
China	
Chili	20,000
Colombia	20,000
Costa Rica	20,000
Denmark	
Danish West Indies	
Ecuador	25,000
Egypt (informal)	
France	80,000
Algeria	
Germany	52,840
Great Britain	25,000
Barbadoes	1,200
British Columbia	
British Guiana	5,000
British Honduras	1,500
Cape Colony	5,000
Ceylon	8,000
India	
Jamaica	4,000
Malta	
Mashonaland	
New South Wales	30,000
New Zealand	
Queensland	
South Australia	
Tasmania	
Great Britain—	
Trinidad	£3,000
Victoria	15,000
West Australia	
Guatemala	24,000
Hawaii	
Hayti	
Honduras	4,000
Italy (informal)	
Erythria	
Japan	126,153
Korea	
Madagascar	
Mexico	150,000
Netherlands (informal)	
Dutch Guiana	2,000
Dutch West Indies	1,000
Nicaragua	6,000
Orange Free State	
Paraguay	5,000
Persia	
Peru	25,000
Russia	
Salvador	1,400
San Domingo	
Siam	
Spain	
Cuba	5,000
Transvaal	
Turkey	
Uruguay	
Venezuela	
Total	£845,915

Besides the above-named countries, the appropriations of which it is assured will in many cases be increased, it may be considered certain, from information received by the Direction, that Sweden, Norway, Hungary, Switzerland, Canada, and several others will be added to the list; and, at a low estimate, it is thought the appropriations of foreign nations will amount to £1,000,000 sterling. Building sites have been selected for Great Britain, Germany, Japan, Turkey, Mexico, Peru, Brazil, Ecuador, Colombia, Costa Rica, Guatemala, and Chili, and the constructions of foreign countries will be of very varied description. Zanzibar alone has reconsidered its acceptance of the invitation to participate.

TRANSPORTATION.

To the grounds.—The only drawbacks to the site of the Exposition are its distance of seven miles from the centre of the city, and the distance Chicago is from the Atlantic. At present, the Illinois Central Railway, which runs along the borders of the Lake, conveys home daily, between the hours of 5 and 6.30, about 5,000 people out of the city in the direction of Jackson-park, and during the same time, about 40,000 people daily travel home by cable and horse car. These modes of conveyance may extend their capacity, and the elevated railroad, which has been partly completed, will no doubt be ready to bear its share. It is also expected that steamboat companies will start lines from the city to the park, and that the means of reaching the ground will be increased, so that a maximum of 400,000 can be daily conveyed to and from the Exhibition. The peculiarity, however, of Chicago is that, though it occupies an enormous extent of ground—178 square miles—the principal business, the hotels, stores, public buildings, and the railway and car termini, are almost all concentrated in about one-half mile square, and from the configuration of the city, and the north and west sides being separated by the river from each other and from the south side, almost everything passes through that small northern part of the south side, which is now much crowded.

In the grounds.—With regard to the conveyance of people round the grounds, plans are not definitely adopted, but several companies are ready to provide the means, and the only decision arrived at is that the tracks must be elevated. One of the plans now under trial is a continuous movable sidewalk, or platform, with a capacity of 40,000 an hour, to be continually moving at the rate of three miles an hour, and alongside it another platform moving at the rate of six miles an hour. The portion on trial has been working for the last month, and has met with general approval, the habit of getting on to the platform in motion being quickly acquired. Definite arrangements are yet to be perfected for the conveyance of visitors to Chicago from different parts of the country, but reduced rates, it is said, will prevail.

Freight for Exhibits.—With regard to freight rates for exhibits, arrangements have been made with nearly 500 railway and steamship companies. The following memorandum has just emanated from the Direction at Chicago:—

"Freight rates: on the subject of freight rates from the seaboard ports to Chicago, on exhibits for the World's Columbian Exposition, to be held in 1893, it may be announced that the following arrangements have been perfected, which, however, are subject to a modification which it is hoped may be effected. The Freight Traffic Association of the country, of which the leading transportation lines are members, have uniformly adopted a tariff of full rates on the forward journey, granting free return of the exhibits to the seaboard, provided ownership remains unchanged.

"The following schedule of class rates in effect at the present time (December, 1891) between the principal seaboard ports and Chicago (subject to change) are:—

From	1st class.	2nd class.	3rd class.	4th class.	5th class.	6th class.	A.	B	C	D
New York	75	65	50	35	30	25				
Philadelphia ...	69	59	48	33	28	23				
Baltimore	67	57	47	32	27	22				
Boston...........	75	65	50	35	30	25				
Portland Me...	65	57	44	3	26	22				
Newport News	59	51	43	29	25	20				
Montreal	65	57	44	31	26	22				
New Orleans...	1·18	98	78	61	50	44				
San Francisco.	4·20	3·70	2·95	2·30	2·00		2·00	1·80	1·45	1·30
Portland Or....	4·20	3·70	2·95	2·30	2·00		2·00	1·80	1·45	1·30

"To the above rates there will be added a sum not to exceed 8 cents. per 100 lbs. This is a terminal charge covering the switching of exhibits into the Exposition grounds from the point of intersection with the Illinois Central Railroad, and the placing of exhibits on or adjacent to the space allotted. This charge of approximately 8 cents will be made in both directions.

"From the above it will be seen that freight rates from New York to Chicago, including switching and terminal charges, as specified above, vary from half a cent to one and a half cents per ton per mile.

"When property is shipped on a through bill of lading, to and from Chicago, there will be no charge for transfer from steamer to rail at the seaboard.

"The class rates herein quoted will, it is be-

lieved, cover such exhibits as are not of a particularly high grade.

"Exceptionally fine goods, such as statuary, paintings, and fragile articles, which are classified from one and one-half to double first-class, are charged at proportionally higher rates than those scheduled.

"Freight charges on exhibits must be prepaid at the point of shipment, the goods being delivered at the Exposition clear of all charges incident to their transportation.

"A condition of the free return of unsold exhibits is that they shall be transported over identically the same routes as were used in forwarding them to Chicago.

"*Storage Rates for Empty Cases.*—The maximum charge for removing, storing, and returning empty cases, and packing material, without insurance, two (2) cents per cubic foot. For empty cases and packing material, with insurance, two and one-half cents (2½) per cubic foot. Neither these storage rates nor the terminal charge referred to above are definitely determined. It is hoped that both may be modified.

"The following statement, reproduced for comparative purposes, shows the cost of similar service at other Expositions :—

			Per Cubic Feet.
London	1862		$·059
Vienna	1873		·02
Philadelphia	1876	(without insurance)	·018
Paris	1889	(„ „)	·029
Paris	1889	(including insurance)	·162

"While the arrangements with trans-oceanic and other steamship lines are as yet incomplete, the Exposition management has every reason to believe that liberal concessions will be made by all the leading lines touching at New York and other seaboard ports."

Insurance.

The amount of insurance placed on the main Exposition buildings up to the end of the year exceeded £200,000, and this will be gradually increased as their construction progresses. It is estimated that not less than £35,000,000 or £40,000,000 insurance will be eventually carried on the buildings and exhibits. The Exposition ground is already provided with a full equipment of fire engines and apparatus, and every precaution is being taken against fire.

Insurance Memorandum.—The following Insurance Memorandum was issued on the 6th January, 1892 :—

"The Insurance Auxiliary Committee has suggested that insurance, both marine and fire risks, be obtained in the country from which exhibits are sent. The Committee is unable to name the ocean rate, as it varies according to the port.

"The fire risk of Exhibition buildings, at present, would be at the building construction rate, which will be modified somewhat when the buildings are completed. On the temporary Insurance Diagram, attached herewith, will be found the present rate marked in blue pencil.*

"To obviate the difficulty of obtaining full fire insurance in this city on exhibits, which will probably begin about the end of this year, the Committee suggest that exhibitors obtain in their own country as much insurance from domestic companies as possible.

"No arrangement has been perfected as to insurance of goods while on exhibition, but the Committee will have prepared, some time prior to the arrival of exhibits, a schedule of insurance acceptable by the majority, if not all, of the sound fire insurance companies of the world, so that owners desiring insurance to be placed here will have all information."

General Regulations.

Information for Foreign Exhibitors.—A further circular of information for foreign exhibitors has lately been issued, embodying the regulations governing the free import of articles for exhibition, issued from the Treasury Department at Washington on the 5th November last. (Copy forwarded in Despatch No. 5, Commercial, of the 19th December, 1891.) Though free of entry for exhibit, duty will be levied on all goods sold in the country. Articles will not be received after the 10th April, 1893. If articles are for competition, it must be so announced. No charge for space or limited power is made. The mode of addressing articles must be strictly adhered to, and facilities will be afforded for the through transit to and from Chicago. The exhibitor must be bound by the regulations contained in the circular.

Classification.—A new classification has been issued, comprising 12 departments, 126 groups, and 968 classes. (Copy forwarded in Despatch No. 7, Commercial, of the 29th December, 1891.)

* This diagram is merely a plan of Jackson-park, similar to that which appeared in the *Journal*, December 11, 1891.

WORLD'S CONGRESS AUXILIARY.

The World's Congress Auxiliary will be a great attraction and feature connected with the Exposition. It is recognised and approved by the United States Government, and is organised to provide for the presentation, by papers, addresses, and discussions, of the mental and normal status and achievements of the human race. The Congress embraces a number of Departments, such as literature, Government, education, music, science, engineering, &c., in each of which there are subdivisions. It is believed there will be at least 100 congresses held. A building capable of holding a large number of persons will be constructed for this purpose on the Lake front. Congresses of artists, including every branch of art, will form a feature of the World's Auxiliary Congress. A General Committee has been formed, with Sub-Committees, on the Congresses of architects, painters, sculptors, and decorative artists. The topics of discussion embrace all subjects relative to the various branches of art.

OTHER ATTRACTIONS.

In the Women's Building will be afforded the opportunity of showing the achievements of the sex, and the adaptability of women to different occupations in industry, charity, and other work. The most excellent specimens of their work from all countries will be collected in this building.

As an American Exhibition it will be unique, and one of the most striking and novel features will be the extensive exhibits from Mexico, Central, and South America, which have had no such former facility, or availed themselves in such a degree as is now assured of similar opportunities of representation. The horticultural show promises to be brilliant and various. Almost every foreign country has applied for space in the building, 43,800 feet having been already allotted, besides 275,000 feet outside the building. There will be exhibits from all parts of the world, where collectors are busy, as well as from the States of the Union, for each of which space is reserved.

Music and concerts will be carried on on an extensive scale. A great display of fireworks will take place at night. A number of restaurants will be provided, capable of seating 8,000 people, and several thousand seats will be placed in the grounds. It is decided that liquor will be allowed to be sold. A natarium, and every description of bath, will be furnished on the ground, and a number of other constructions not here enumerated.

The city itself affords many attractions from the wonderful rapidity with which it has sprung up, its energy, its buildings and manufactures, and its great system of parks, connected by forty-five miles of boulevards. The city will spend a large sum—about £400,000—in putting the streets and parks in thoroughly presentable condition by the time the Exposition opens. About twenty new hotels are in course of construction for the accommodation of visitors.

An International Naval Review is planned for April, 1883, in New York Harbour, and the mobilisation of 10,000 Militia and several thousand regulars, while the Exposition is open, is also contemplated.

PROSPECTS AND ADVANTAGES OF EXHIBITS.

Prospects of Exhibits.—Applications for space from the different States of the Union are coming in fast; more than 2,000 have already been made, and the greatest assurance is felt that the representations of the separate States will be on a very extended scale. A few exhibits have already arrived. From foreign countries the information received by the management is considered most encouraging, and reports from the Commissioners now visiting the South of Europe, and from other agents, are said to be highly satisfactory. Interest appears to be very generally taken, in almost every quarter of the globe, with a view to a thoroughly representative show. New plans for various exhibits are constantly being received by the Management, and applications for space are described as overwhelming. A few days ago, New South Wales asked for 200,000 feet. In the Art Galleries, where space has been already allotted to a few foreign nations, France has recently applied for 82,000 feet. Everything tends to show that the representation of foreign countries will be of a most comprehensive and wide character, and the thought is beginning to arise that it will be more a question whether the buildings, enormous as they are, will be large enough to contain all the exhibits which promise to arrive, than that there will be space unoccupied. The position of the Exposition is already assured, unless some unforeseen incident occur, as the largest and most comprehensive exhibition ever held.

Advantages.—With regard to the advan-

tages of exhibiting, it must be borne in mind that the Exposition is a thoroughly international one, and not only that the best productions from all parts will be brought together, but that it will be visited by a multitude of people, many of them the most intellectual of all countries. It will afford the exhibitor an unequalled opportunity for his goods to be seen and compared with those of other nations. It will afford the widest scope for increasing commercial relations with this and every other country, and the field offered by the United States is a large one. Every year the population and the demand for every article increases, as well as the money at disposal for the purchase of works of art, glass, china, and all fine goods. Notwithstanding the heavy duties, which may some day be changed by a liberal policy, there is still a demand for those articles which cannot be produced to such perfection in the United States, and a risk is run by those who do not exhibit of losing the foreign customer they now have, which may be taken by those who do. The Exposition may also lead to a wider appreciation of the foreign production, and possibly to the establishment of branches or agencies which are practically non-existent in this part of the country. In these days of high competition, too, when foreign nations will have a hard fight to maintain the position they hold in the markets of Central and South America, it is of no small importance that British goods should be well represented, so that their quality may be seen and compared not only with American but with other European goods, and the price at which they can be furnished more widely known.

Labour Contract Law.—It is assured that the Contract Labour Laws will not in any manner stand in the way of foreign exhibitors importing persons in their employment for Exposition purposes, as in the opinion of the highest legal authority in the country such persons would be outside the intention of these recent laws.

Patents.—With regard to patents, the American law is of a liberal character, and from information received from the World's Fair Commission, some particulars on the subject will shortly be circulated.

Dedication and Opening.

The World's Columbian Exposition is under the auspices of the United States Government. The buildings, which will then be completed, will be dedicated, with inauguration ceremonies extending over three days, on the 12th October next, the 400th anniversary of the discovery of America by Columbus, when the President of the United States, the Senate and members of Congress, the Governors of States and their staff, and the representatives of foreign countries will be invited. The time between October 12, 1892, and the 1st May, 1893, when the Exposition will be open to the public, will be occupied in receiving and arranging exhibits. The Exposition will close on the 30th October, 1893, and all exhibits must be removed by the end of the year.

Proceedings of the Society.

EIGHTH ORDINARY MEETING.

Wednesday, February 3, 1892; CHARLES MALCOLM KENNEDY, C.B., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Clarke, Somers, 15, Dean's-yard, Westminster, S.W.

Goodman, Professor John, The Yorkshire College, Leeds.

Handcock, Henry W., Lanorna, Blyth-road, Bromley, Kent.

The following candidates were balloted for and duly elected members of the Society:—

Barrett, Arthur, 114, High-street, Kensington, W.

Foord, Alfred Stanley, Tay-villa, Richmond-gardens Romford-road, Forest-gate, E.

Hindmarsh, George Lisle, 29, Regent-quay, Aberdeen.

Hughes, Thomas W. R., 11, George-lane, Lewisham, S.E.

James, J. H. Cordner, 10, Mansion-house-chambers, 11, Queen Victoria-street, E.C.

Jarman, Captain Stephen, R.N.R., Dartmouth villa, Evering-road, Clapton, N.E., and 19, Birchin-lane, E.C.

Maund, John Oakley, 80, Portland-place, W.

Watney, John, Mercers'-hall, E.C.

Wyon, Allan, 2, Langham-chambers, Portland-place, W.

The paper read was—

DUST AND FRESH AIR: HOW TO KEEP OUT THE ONE AND LET IN THE OTHER.

By T. Pridgin Teale, M.A. Oxon., F.R.S.

Except in the case of museums, few serious attempts have been made to exclude dust from rooms, closets, cupboards, and drawers, to the contents of which, not unfrequently, dust is simply ruinous. We allow dust to run riot amongst our things of value, and then go to considerable expense to render them clean again, only to start them on a fresh career of defilement.

Looked at in the abstract, is not our passive capitulation to dust incomprehensible? When I enter an office in a town and see the window sills and papers dotted with soot, or go into a bedroom and see the toilet table defaced with blacks, and know that the soot and the blacks need not be there, I cannot refrain from asking how comes it to pass that we so patiently submit to such perpetual discomforts. You will doubtless reply, We agree with you as to the existence of the evil, but how is it to be remedied? The object of my appearance here to-night is to offer some practical suggestions whereby you may so far mitigate and reduce the evils of soot and dust as to make them tolerable, perhaps even to lay down principles by which the evils can be annihilated in those instances in which the result to be obtained is worth the cost of achievement. For the practical purposes of everyday life it may turn out that we had better be content with approximate perfection, a condition of existence which compels us to be content with approximately pure water from a filter, and approximately pure air in our living rooms.

How does Dust get in?

If dust is to be kept out of any cavity, we must first find out why the dust gets in, in spite of good workmanship and accurate fitting. The reason is simple, ridiculously simple when stated, but, curiously, it has been little, if at all, thought of, and certainly hardly ever acted upon in practice. And the reason is this. Closets, cupboards, drawers, and boxes contain air; if the air were inelastic and never altered in volume there would practically be no entrance of dust into these closed cavities. Unfortunately for our cleanliness, air is changing in volume incessantly. We are all familiar with the barometer, and most of us no doubt understand why the quicksilver rises and falls in the glass tube, or why, in the aneroid barometer, the index moves to right or left. Let us consider what these changes mean, and what they record.

When the air around us becomes condensed—shrinks into a smaller volume—it becomes heavier, puts greater pressure on the surface of the mercury, and makes it ascend in the tube; then the mercury is said to rise. When the air expands—swells into a larger volume—it becomes lighter, the pressure on the mercury is less, the mercury sinks in the tube, and the barometer is said to fall. Therefore, every change of height of the quicksilver which we observe is a sign and measure of a change in the volume of air around us. Further, this change in volume tells no less upon the air inside our cases and cupboards. When the barometer falls, the air around expands into a larger volume, and the air inside the cupboard also expands and forces itself out at every minute crevice. When the barometer rises again, the air inside the cupboard, as well as outside, condenses and shrinks, and air is forced back into the cupboard to equalise the pressure; and, along with the air, in goes the dust. The smaller the crevice, the stronger the jet of air, the farther goes the dirt. Witness the dirt-tracks so often seen in imperfectly-framed engravings or photographs. Remember, ladies and gentlemen, whenever you see the barometer rising, that an additional charge of dust is entering your cupboards and drawers. So much for the barometer, which is a very restless creature, rarely stationary for many hours together. But this is not all. We also have the thermometer. The temperature of our rooms varies daily—often considerably—between mid-day and midnight, and greatly between summer and winter. What does the thermometer tell us? Not less than the barometer does it tell of change of volume of the air, though it is probably not so rapid in its effect upon the air in enclosed spaces as is the change of volume indicated by the barometer. Many of you have seen a fire-balloon. The heated air, filling the balloon, expands, and becomes lighter than the surrounding air, and up goes the balloon, until, the source of heat having become exhausted, the contained air cools, contracts, becomes as heavy as the surrounding air, and down comes the balloon again. So, also, as temperature rises outside our cases, the increased warmth is slowly conducted to the air inside the case, which expands and escapes through the crevices. Then, when the time for cooling comes, the

air inside slowly contracts, and back rushes the air through the crevices, and again in goes the dust. Thus, we see we have two factors constantly acting, one or other tending to produce daily, nay, hourly, changes in volume of our dirt-carrying air.

In order to inform myself of the amount of change of volume that could, under extreme conditions, possibly take place, I asked Professor Rücker to kindly calculate for me the change of volume that would take place in 100 cubic feet of air, between a temperature of 30 degrees, *i.e.*, just above freezing point, in combination with the barometer standing at 30 inches, or about "fair," and a temperature of 60 degrees, combined with the barometer standing at 29 inches, or "stormy." He told me that the difference would be about 10 cubic feet, or one-tenth; in other words, that a closed case of 100 cubic feet, if hermetically sealed at a temperature of 30 degrees, with the barometer standing at 30 inches, would have to resist the pressure equivalent to the addition of 10 cubic feet, when temperature rose to 60 degrees, and the barometer fell to 29 inches. Have we not now discovered the reason why dirt enters closed spaces? What shall be the remedy?

Seeing, then, that air will find an entrance, and in the nature of things must get in—well, we must let it in, not at innumerable uncovenanted small crevices, but at our own selected opening, specially provided. Then we are in a position to strain off the dust by providing the selected opening with a screen, which acts as a filter. These, then, are the general principles on which we must act. The rest is a question of detail. The details range themselves under three heads:—1. What is the most effective, or the most generally applicable filtering material? 2. Given the filtering material, what ought to be the proportion between the area of the screened opening and the cubic contents of the case to which it has to be fitted? 3. What, in any particular instance, is the best situation for the filter?

A.—Filtering Material.

What is needed in our filtering material is that it shall readily allow air to pass through, and shall also possess the quality of arresting in its meshes fine particles of dust. For some purposes it may suffice to use a coarse canvas, the threads of which are not too closely twisted and have an abundance of fine fibres projecting from them, thereby reducing the small squares of the woven texture to a still finer mesh. The material I have used most frequently is "bunting," but it has disappointed me. When examined by the microscope many of the small squares of mesh are seen to be deficient in delicate fibres standing out from the threads, which would enhance the filtering power of the texture. Lately I have tried other materials, domette, flannel, and cotton-wool between layers of muslin, such as is used for dressing wounds under the name of Gamgee tissue. Cotton-wool is probably the most perfect filter. Indeed, so perfect is it that in the new science of bacteriology it is used as an effective means of excluding dust and germs from flasks in which experiments are to be carried on. In order to put various textures to an exact comparative test, an experiment was tried. Having selected six quart bottles with wide mouths, I tied over the mouth of each a piece of the filtering tissue which I wished to test. The bottles are not liable to crack, as wooden boxes are; the only access for the interchange of air in the interior was through the filtering texture. I thus had a means of testing the comparative value as strainers of the various materials. Within the bottles were placed glass slides on which any dust that was carried in might settle. The experiments were begun on May 5th, 1891, and the slides were taken out on January 6th, 1892, and most carefully photographed by Mr. Lafayette, and made into lantern slides.

The bottles were placed near a window in a room in the building of the Leeds Philosophical Society, *i.e.*, quite in the centre of Leeds. The materials tested were:—

Canvas.
Bunting.
Ordinary flannel.
Domette flannel, rough side in.
Domette flannel, rough side out.
Cotton-wool, 1 inch thick.

The results of the experiments are now shown you by the lantern. It will be seen that as a consequence of eight months exposure, including a week of the worst fog I ever knew in Leeds, three of the filtering tissues admitted a very appreciable amount of dust, viz., coarse canvass the most, bunting coming second, ordinary flannel admitting less than either. The other three bottles were screened, one with thick domette rough side in, one with domette rough side out, and one with cotton-wool about an inch in thickness. The three last show hardly a trace of dust. Curiously, the cotton-wool shows a trace more than

the domette flannel. The explanation of this I suspect to be that the cotton-wool was not tied firmly enough round the neck of the bottle, which had no rim, and that some air passed between the bottle and the wool, instead of through the wool.

Another experiment which I tried was to fit up a cupboard with panels of double domette flannel. After the fog, to my surprise, the inner screen had become more or less black, showing that black particles had passed into the cupboard, but with this remarkable difference: whereas the outer flannel was almost uniformly black from top to bottom, the inner flannel was divided into four squares of different shades of blackness, corresponding to four spaces between shelves. Of these four, the lowermost was almost as black as the outside, and the uppermost was almost clean. I just mention this as a fact which needs an explanation, but without suggesting one.

There is one error which I think has been committed in the screens made for me, and it was pointed out by my friend Mr. White, the architect, of Wimpole-street. The filtering material is likely to act more effectively if left loose and not stretched tight, as when tense the interstices are stretched and made larger, and when out of sight it might be very loose, almost baggy, with advantage.

Hoping to get some hints as to the comparative value of the various textures under trial, I placed specimens of each under the microscope. It is obvious that both canvas and bunting are of too open a texture, having numerous small holes unguarded by delicate fibres. Judging by the microscope, one would conclude that of woven textures, probaby flannel, and still more, domette flannel, are the best, and this judgment seems to be borne out by the experiments with the bottles.

B.—The Proportion between the Filtering Opening and the Cubic Contents.

This is a question which experience alone can decide. Doubtless the larger the area of screened opening, the more effective the filtration. For a bookcase with glazed front, probably the whole of the back might be made of flannel loosely fixed over the necessary skeleton framework. For a cupboard or closet, every panel should be replaced by a screen. If the closet have a window, all crevices and joints in the window should be pasted up to exclude the soot, otherwise the wind from the outside, or the fires of the house from the inside, will force the air soot through. On the other hand, it is probably true that, given very perfect fitting and workmanship, aided by the interposition of velvet, as hereafter described, where the edges of the doors come into contact with their frame, a much smaller area of filter, perhaps even a simple tube, filled with cotton-wool, may prove to be efficient. These, however, are points on which further experience is needed, and which may, ere long, be settled by experiment.

C.—The Situation of the Screened Opening.

Where shall we place our screen? This is a question which admits of a variety of answers, and gives scope for endless ingenuity. In anything which is being newly made, such as the cupboards and closets of a new house, or in new furniture, we are masters of the situation. In many of them we may substitute at the back our filtering texture for wooden boards, and perhaps even save expense thereby. In closets we may replace the panels of the door by filtering texture, guarding the closets, if necessary, against thieves by wire netting or iron bars fixed on the inner side. As a rule, chests of drawers may have the filter over the whole surface at the back, care being taken that the back of each drawer falls half an inch short of the top of the drawer, to allow free entrance of air from the screen. In one set of drawers, so placed that I could not get at the back, the difficulty was got over in this way:—In the front of each drawer a series of twenty holes, of an inch diameter, was made for admission of air. The filter, on a frame, was fixed on the inner surface of the front of the drawer, so that the material should stand half an inch away from the holes. A somewhat similar plan was adopted in a bureau. About 20 large holes, two inches in diameter, were cut in the woodwork at the back, some of the holes being opposite pigeon holes. Then the whole was covered with bunting, on a frame so arranged that the bunting was fully half or two-thirds of an inch away from the wood. Another method has been adopted at the Yorkshire College for some of the cases. The filter was applied at the roof, somewhat after the fashion of a weaving-shed roof, the vertical face being filled in by the screen. Again, Mr. Branson has provided a roof filter for a case of scientific instruments, by placing the screen in the roof of the case, and protect-

ing it by a false roof two inches above it, to prevent its being choked by falling dust.

How to Deal with Crevices.

What shall we do with crevices and cracks? At first, I hoped that narrow chinks might be ignored, on the principle that easy passages of air through an ample screen would virtually stop off currents through narrow spaces. In this I have been disappointed, as, in some cases, a chink, though apparently narrow, has proved too accommodating to the passage of air, and a more ready channel than the interstices of flannel. My rule now would be to close or guard with filtering material every place where the door comes into contact with its frame.

The plan I have adopted with the doors of several cupboards and closets is this—to put strips of cotton velvet wherever the door comes into contact with its framework. On the side where the hinges are, the velvet is glued and sprigged to the edge of the door: on the other side and the top the velvet is fixed to the rebate against which the door presses. If the door belong to a closet, and the bottom is not in close contact with the floor, a small piece of flannel or cloth may be fixed along the inner side of the bottom of the door, so as to form a curtain which closes the gap, and filters any air that passes through.

Such, then, are the principles which may guide us to a victory over dust, and such are some of the details whereby we may work out a method by which the victory is to be won. Do not suppose that I claim to have completely conquered the enemy; but a beginning has been made, a beginning definite enough and assured enough to encourage others, and especially architects, to study the question and to make trials. If they will but work with determination to conquer, they may confer upon the community a most welcome amelioration of some of the smaller miseries we have to submit to.

A Model Room.

And now let me venture to tell you what I should do were I to construct an office in the centre of a town. I should begin with the fireplace. Let it be constructed on the principles I have been teaching for the last ten years, and which were brought to a focus in my lecture at the Royal Institution in 1886; principles which are at last influencing the construction of firegrates throughout the kingdom. Shortly stated, they are:—

1. The back and sides of the fireplace to be firebrick, built solid.
2. The depth of grate from front to back never to be less than 9 inches.
3. The back to lean over the fire, not to lean away from it.
4. The front bars to be vertical and thin, not horizontal and thick.
5. The ashplace under the grid to be made into a closed hot chamber by a moveable shield, named an "Economiser."

The effects of this construction are:—

(*a.*) Great diminution of dust, since the ashes fall into a closed ash chamber.

(*b.*) Better warming of the room, with a diminution of about one-fourth in the quantity of coal used.

(*c.*) Diminished draught across the floor, from diminished roar up the chimney when the fire is burning briskly.

(*d.*) Diminished production of soot.

These are the principles which I have urged, and they are open to everyone to adopt. I do not speak of a further improvement, as it is the subject of a patent, and is not open to everyone to copy.

Having made sure of my fire, the next step would be to secure admission of air to supply the fire, without making a draught or introducing dirt. As far as I know this is best done by the "Harding diffuser," which admits air directly from the outside and delivers it through a series of small jets near the ceiling. To shut out the smuts the air passes through a canvas screen placed diagonally in a flat tube, which leads up to the "diffuser" and gives a filtering area about six times the sectional area of the tube. This air is admitted into the room by a legitimate channel, and is filtered. The "Harding diffuser" was once patented, but the patent has lapsed.

Having thus secured a supply of air for the chimney, we can afford to deal with the windows, and make them air-tight, without fear of the chimney smoking. Now I should like to see a revolution in windows, at any rate, wherever we can be content with panes of moderate size, and can have the heart to surrender plate glass.

Three things are required of a good window.

1. That the outside of the window may be cleaned by a servant standing inside the room, whereby the risk and expense of cleaning from without is avoided.
2. That it shall exclude wind and dirt, even under the stress of a gale.
3. That the air of the room, especially in

frosty weather, shall not be itself so chilled by contact with the large surface of glass as to cause induced cold currents, which have not even the merit of being air freshly introduced.

To attain these points, the sash window must be abandoned. The window must be so divided that one half vertically, or in a large window one-third, may open inwards on hinges, the other half or two-thirds being fixed, and therefore wind tight. The breadth of each division to be such that a servant's arm can reach out and clean the outer side of the fixed window as she stands inside the room. In the case of three divisions the fixed windows would be to the right and left of the hinged window. The hinged window should be in two or three divisions, according to the height, not in one large casement from top to bottom. Thus have we provided for my first requirement, the cleaning of the window. The hinged window must be so constructed that when closed the framework of the window locks into a double rebated fast frame, after the manner of a jeweller's show case. Then, if well made, it would fit tight and keep out wind and dust. This provides for my second requirement.

Lastly the panes should be doubled, that is, a second pane must be placed inside the ordinary pane at a distance of about 5-8ths of an inch. The outer pane is fixed by putty in the usual way. The fixing of the inner pane is peculiar and all important. The inside of the frame is cut to receive the glass exactly in the same manner as the outer side for the outer pane, but the inside pane must not be fixed by putty, but is held in place, "sprigged" firmly against its rim, "the rebate," by small nails, two in each side, very carefully put in. Why do I insist upon this mode of fixing the inner pane? For two reasons—one, to make it easy to remove the inner pane if ever it should be necessary to clean the inside of the two panes; the other reason is, to enable me to render cleaning of the inside unnecessary. How is this achieved? By facing the flange, against which the pane is pressed, with cotton velvet. The air that must perforce pass in and out of the space between the panes must pass the velvet, and be filtered. Two windows of my bedroom thus treated five years ago have never needed to be cleaned; and a pane, which was removed at the end of four years for inspection, was absolutely clean. Another advantage of the double panes is this:—When my other windows with single panes are steamed all over, and even glazed by the frost, the outer panes of the double window show hardly a trace of unfrozen steam; the inner panes are never steamed. Again, a thermometer placed between the panes has never been below 30° all this severe weather, even though a thermometer outside the window has been several times below 20°.

Lastly, I would treat the cupboards and drawers after the manner already described. The result would be, not absolute freedom from dirt, nor absolute protection from London fog, but such a departure from what is commonly experienced as to make the experiment well worth all the trouble it costs.

DISCUSSION.

Sir HENRY TRUEMAN WOOD said the first objection to Mr. Teale's ideas was, that the carrying of them out demanded so much better workmanship than the ordinary workman would give, or the ordinary purchaser of houses would pay for. The experiment with the wooden boxes, which failed, seemed, therefore, a more practical one than that with the glass jars, as it more nearly represented the ordinary condition of things. The air would naturally follow the path of least resistance; and, unless the cupboards or drawers were made with the utmost accuracy, there would be chinks and openings much larger than those in the filtering materials would supply, and the air would probably prefer to pass that way rather than through the trap provided to catch the dust. In that very room might be found an example of what was done by the Society to exclude dirt and dust: the air which came through the grating along the wall was filtered through a fabric placed in the opening through which the air came; and it was astounding to see the amount of filth deposited on the fabric in three or four weeks. The screens, therefore, would constantly require cleaning, if they were to have any effect. He would suggest that, if the experiment with the glass jars were repeated, one should be left with no filter at all, so as to see the amount of dust deposited under ordinary circumstances. The small particles which were seen in the one covered with cotton wool were, very probably, in the jar before it was closed, or might have dropped from the cotton wool itself. He was not surprised at the thermometer between the double windows showing 30°, when one outside stood at 20°; probably one inside a room with a single window would have have shown about the same temperature.

Mr. W. SMARTT said some time since he placed an empty wine cask, carefully corked up, in an exposed position, and on examining it shortly afterwards found that a considerable quantity of water had got in. He concluded that the air inside had expanded and then contracted again, and sucked the water in;

it was no wonder, therefore, that air should make its way into drawers, &c., and carry dust with it. He suggested that the air chamber under the fire grate should have water placed in it, which would prevent the dust flying about; he had found this plan very effectual in a greenhouse fire. Many years ago, a system was devised by Sir Douglas Galton of dividing a chimney-flue longitudinally, and admitting pure air to the room through one half, which was at the same time warmed by the hot vapour in the other half; the plan had been employed in barracks, and he fancied effected considerable economy. If windows were made perfectly air-tight, he doubted whether sufficient oxygen for the purposes of health would be admitted to bedrooms.

Mr. WHITE said anyone who lived in London must feel grateful for an effort, which promised to be successful, in diminishing the dust nuisance which was the cause of an enormous expense to all householders. It was rather hard on architects, however, to have another obligation cast upon them, in addition to the multitude for which they were already held responsible. With regard to cupboards and presses, the only way of making them secure would be for some practical person to undertake the construction of dustproof receptacles, otherwise there would be little chance for many years to come, on account of the trouble and expense involved in keeping these strainers clean. If they were not regularly cleaned, perhaps once or twice a week, the whole effect would be lost. There could be no doubt that in the ventilation of a house, if a sufficient amount of air could be introduced at the upper part of a room, it would be so warmed before it came down to the lower part, that no draught would be felt, and this would facilitate permanent ventilation without the necessity for opening doors and windows, and so admitting dust. As to curing fogs, it was not by any means a simple matter. He understood that it was not merely the unconsumed carbon which polluted the air, but that the sulphurous and other chemical products held the carbon in suspension. At some future time it might be possible to disperse the fog by means of electricity, when it could be produced more cheaply. He was thoroughly convinced of the value of Mr. Teale's firegrates, and the closed chamber for the ash was really the key to the whole matter; being shut off from the cold air it became hot, and combustion was rendered much more perfect. The method of filling the chamber was introduced some 35 years ago by Mr. Moule, the inventor of the earth closet, and once he had the whole of the grates in his house fitted with them, but the result was to produce such an amount of heat that he gave it up rather than reduce the size of all the grates. No doubt the heat thus generated would do a great deal to consume smoke.

Mr. H. H. STATHAM confessed to feeling a little disappointed at not hearing something about what dust really was. Was it certain that a great deal of the dust did not arise in the rooms themselves, from the disintegration of various materials which was constantly going on. He did not like the idea of admitting air at the top of a room, because all the heated and vitiated air collected there, and the fresh air coming in would be contaminated with it. He should therefore prefer introducing it at a lower level, say four or five feet from the floor.

Mr. OLIVER J. WILLIAMS suggested that the glass in the double windows would, like air, contract and expand with variations in temperature, and that it would be well therefore to have some kind of spring for it to rest against. The double window system no doubt had many advantages, as those who had travelled in Russia well knew. An improved system of ventilation was much wanted, especially in London offices, where they suffered much from draughts, and which were very difficult to keep warm.

The CHAIRMAN, in proposing a vote of thanks to to Mr. Teale for his interesting and suggestive paper, said they all knew how dust abounded in London; and if they did not know exactly what it was, it seemed to increase with the introduction of wood pavement. In the West of England dust is called "pillum," and when a native of that part was asked what pillum was, he said, "Oh, to be sure, pillum is mucks a-dry." Then he was asked what mucks is, and his answer was, "Don't you know? mucks is pillum a-wet;" so he did not advance the matter further than other statements we have heard. Builders and workmen find it very difficult to change their traditional mode of construction, and it is necessary, therefore, to reiterate these instructive lessons contained in Mr. Teale's paper again and again, for the abundance of dust in London not only causes inconvenience, but is a source of serious injury to countless articles of value, as well as fabrics, furniture, and house decoration.

The vote of thanks having been carried unanimously,

Mr. TEALE, in reply, said he would admit that any contrivances such as he had described would need occasional care in cleaning; they would not continue to act automatically. Screened-in ventilators must be cleaned frequently, and in cupboards, &c., perhaps once a year, and renewed at longer intervals. It was also true that thoroughly good workmanship was necessary, but he thought the game was worth the candle; it was much better to catch all the dirt on a screen instead of having it on the papers or articles in the receptacle. Although it would not be possible to introduce these things universally, or even generally, there were conditions and positions where it would certainly be worth while; and if this investigation were undertaken by strictly scientific persons, young physicists, who would go into it in the same way as they did into bacteriology, and arrive at conclusions on which practical action could be based, it would be applied to the preservation of those beautiful things

to be found in most museums, which deteriorated so soon by dust. In the Leeds Museum there was a beautiful series of birds just put up. He could not say that he had yet found out how to keep the cases clean, but if they were having new ones made, they must insist on having perfect workmanship, and possibly would succeed in keeping out the dust. It was certainly an oversight not to have had one jar without any filtering material, but his object was to find the comparative value of the different materials, and in that he had succeeded. He should certainly continue the experiments, and should not forget Sir Henry Wood's suggestion, covering one jar simply with paper secured by an india-rubber band. He had never heard of Mr. Moule's suggestion with regard to putting water under the fire, but no doubt the effects attributed to the water were really due to there being a closed chamber. It was not necessary to damp the dust, because it fell into a closed space, and he feared that it would be so much trouble to keep the chamber filled with water that it would be impracticable. With regard to Sir Douglas Galton's plan of introducing warm air into a room, it might be useful in the case of large rooms which could not be kept warm by a good fire; but in rooms of ordinary size, such a device was not necessary, and it was much more comfortable and healthy to depend simply on the radiant heat of the fire. Mr. White had also raised the question of cost and trouble. He could only say, as he had more than once, that if he were beginning life, or had a son who was in want of a career and had mechanical tastes, he would set up a factory for making first-class fittings and furniture which would exclude dust, and he was quite sure in a few years he should do an enormous business. He hoped somebody would do it. He had quite enough to do with dust in its practical effects without going into the question of what it was; but he held the bulk of it in towns was soot; at any rate that was the mischievous part. Of course there was dust in country places from the roads and the sweepings of carpets, &c.; but this kind of dust, consisting of minute portions of texture, wood, &c., was not dirty dust; even in country houses the great nuisance arose from the super-added soot from the chimneys. After a fresh fall of snow, in a few hours quite a deposit of soot would be seen upon the surface; and he believed most people produced a great deal of the soot which went in at their own windows. The bulky particles did not travel very far; and he had seen, even in isolated country houses, quite a lot of soot on the window sills, which must have come there from the badly constructed fireplaces. Since he had altered his own fireplaces he found very little soot on his window sills or in the rooms. With regard to introducing air at the top of a room, he had adopted that plan for some years in his own consulting room, and found it answer perfectly; and another room, which he had ventilated for a friend, which was formerly very stuffy, was now quite comfortable, and the blacks had very much diminished. In another house where he had patients, he had ventilated several rooms in this way, and they were always fresh and wholesome. Foul air went to the top of a room under certain circumstances, but it was more or less stagnant, and the fresh air which came in under the doors and made your feet and legs cold went straight up the chimney without ventilating the room; but that admitted at the top circulated through the apartment. As a practical fact, air admitted in that way did make a room fresh, and did not produce a draught. Lastly, he might say that the cotton velvet, against which the glass was was pressed, acted practically as a kind of spring, and a careful joiner would put in the sprigs so as to keep the glass tight, and without any danger of breaking it.

Miscellaneous.

THE RAILWAYS OF BOLIVIA.

The Republic of Bolivia, with a population of 2,500,000, has an area of 55,000 square leagues, or 275,000 square kilomètres. Situated in the centre of the South American continent, it is bounded on the north and east by Brazil, on the south-east by the River Paraguay and the Republic of that name, on the south by the Argentine Republic, on the south-west by Chili, and on the west by the Pacific Ocean and Peru. The eastern part is level, as if it were a continuation of the Argentine pampas, which extend as far as the plains of Venezuela, forming forests, prairies, and fields of extraordinary tropical fertility. The western part is mountainous, and the Andes range, which forms this region, divides in latitude 22° south, and enters the Bolivian territory in two sections, the western or coast range, and the eastern or principal range. Between these two ranges is found the high Inter-Andine table-land, with an altitude of 12,000 to 13,000 feet above the level of the sea, at the northern end of which is situated the great Lake Titicaca, and towards the southern or central region, Lake Poopó, which receives the waters of the former by means of the River Desagnadero. This table-land is connected on the north with the plateaux of Puno in Peru, and on the south with those of the Argentine Republic. M. Juan F. Velarde, Bolivian delegate to the International American Railway Conference, says, in his report upon the railways of Bolivia, that the central position of that country has retarded the development of its railroads, since it has been obliged to wait until the lines of the neighbouring countries should approach its own frontiers before undertaking their extension, as in the case of those from Mollendo to Puno, and from Arica to Tacna, in Peru, which still remain idle within their respective limits, and that of the Central North Argentine Railway, which is now nearing Jujni, with every probability that it will be extended as far as the Bolivian frontier. Topographical and financial

difficulties for a long time prevented the construction of the railway from Antofagasta to the interior, but they have lately been overcome by the Huanchaca Company of Bolivia, which has succeeded in completing the narrow gauge railroad between Antofagasta and Uyuni, with an extent of 600 kilomètres (kilomètre = ·621 of a mile). The same company has contracted for the extension of this line to Oruro, a distance of 320 kilomètres. The configuration of the territory of Bolivia, and its vast area, gave origin to three channels of communication—by way of the Pacific, the River La Plata, and the Amazon respectively—each one of which is the outlet for a particular region, possessing resources of its own of great value, which will rapidly develop as soon as transportation is made cheap and easy, by the construction of railways. The communications by the Pacific are obtained—by Antofagasta Railway, by the Arica Railway, and by the Mollendo Railway. The Antofagasta Railway, which had to contend against the obstacles presented by an uninhabitable desert, has become practicable, on account of the narrow gauge railway which runs from that place to Uyuni. Uyuni is situated at a distance of 25 kilomètres from the rich mines of Huanchaca, 200 kilomètres from the city of Potosi, 300 kilomètres from the capital, and 320 kilomètres from Oruro. This line crosses a very rich mineral region of much promise. Its prolongation to Oruro, with a branch line to Potosi, will tend to further develop the mineral production. The Arica Railway runs a line as far as Tacna, whence it is intended to build another to Corocoro and La Paz. This work requires an immense capital, since the line has to ascend the coast range at its steepest part. This line is connected with the departments of La Paz, Oruro, and Cochabamba. The Mollendo railway, open to traffic since 1870, has the use of a line which leaves that port, runs through Areguipa, and ends in Puno, covering a distance of 522 kilomètres, or 320 miles. Bolivian traffic makes use of this railroad in connection with navigation by steamer on Lake Titicaca, and the high road from Chililaya to La Paz, 14 leagues. Concessions have been obtained from Peru, as well as from Bolivia, to extend this line as far as La Paz, whence, within a short time, a road will be run to Oruro, in order to form a junction there with the Antofagasta road. It is intended to run a branch line from Oruro to the fertile department of Cochabamba, a distance of 200 kilomètres. The Bolivian part of the railroad from Puno to La Paz extends 150 kilomètres from the Desaguadero. The Government guarantees 6 per cent. on the capital invested. The communications with the River La Plata are carried on by means of the Northern Central Argentine Railroad, and by the River Pasaguay and the high road to Santa Cruz. The extension of the Northern Central Argentine Railway has already reached Salta, and will go as far as Jujni, from which place it will be extended to the Bolivian frontier, the Argentine Government having granted a concession for this. It is proposed to run two railways from the River Paraguay—one from the Gaiva to Santa Cruz de la Sierra, running through the province of Chiquitos, over 750 kilomètres of level country, and another from Bahia Negra to Sucre, with a branch to Santa Cruz, 750 kilomètres in level country, and 500 kilomètres in mountainous and broken country. With these two railroads, and another contemplated, between Paraná and Tarja, communication will be opened with the River La Plata. The northern region of Bolivia, which is of wonderful fertility, and irrigated by the rivers Guaporé, Henes, Mamoré, Beni, and Madre de Dios, and their numerous navigable branches, which all unite to form the River Madera, the principal tributary of the Amazon, in order to enjoy the full benefits of steam navigation; and the products of civilisation requires, says M. Velarde, the construction of a railroad from the Madera to Mamoré, so as to avoid the rapids, which interfere with navigation on these great rivers; and this railway must be at least 180 miles long. The survey of this road has been in the hands of a commission of engineers appointed by the Brazilian Government, and its cost has been estimated at not more than 6,000,000 dollars in gold. In connection with this railway, and in order to make communication with the navigable rivers and the cities of the interior of Bolivia, it will be necessary to construct the following supplementary lines:—From Rio Grande, a tributary of the Mamoré, to Santa Cruz de la Sierra, 150 kilomètres through level country; from the River Chimoré, or Upper Mamoré, to Cochabamba, 250 kilomètres through broken and mountainous country; from the River Beni to La Paz, about 500 kilomètres, also through broken and mountainous country. Workmen, provisions, and timber, for the construction of these railways, are found in abundance in the respective departments of Santa Cruz, Cochabamba, and La Paz, which, it is said, will derive great benefit from them. In conclusion, M. Velarde says, "It is estimated that the freight on the materials for these railways, together with that on the steamers and machinery which will have to be imported for the rivers of Bolivia, outside of the regular traffic, will suffice to give life and impetus, for the first few years, to the Madera and Mamoré Railway, whose importance may be compared, without exaggeration, to that of the railway of the Isthmus of Panama."

General Notes.

CHICAGO EXHIBITION.—The Polytechnic Institution has published in pamphlet form a report of a lecture recently given at the Institution on Chicago and the Exhibition, by Mr. James Dredge. The pamphlet is fully illustrated, and includes information as to the Polytechnic cheap trips to Chicago.

JAPAN SOCIETY.—The first general meeting of the Japan Society was held in the hall of the Society of Arts, on Thursday afternoon, 28th January, with Francis Elgar, LL.D., in the chair. The Society has been formed for the encouragement of the study of the Japanese language, literature, history and folk-lore, of Japanese art, science and industries, of the social life and economic condition of the Japanese people, past and present, and of all Japanese matters. The Society will hold meetings, at which papers will be read, and discussions take place on the subjects interesting to those who have visited Japan, or who are concerned in that which relates to the natural products, topography, literature, arts, commerce, &c., of that country. The society will, by the aid of its members, arrange temporary loan exhibitions, illustrative of the arts, sciences, and industries of Japan, ancient and modern. "Transactions" and "Proceedings" will be published from time to time.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

FEBRUARY 10.—E. PRICE EDWARDS, "Burning Oils for Lighthouses and Lightships." Sir LYON PLAYFAIR, K.C.B., F.R.S., will preside.

FEBRUARY 17.—Capt. F. E. YOUNGHUSBAND, "The Pamirs."

FEBRUARY 24.—ERNEST HART, "Ancient and Modern Art Pottery of Japan." Prof. WILLIAM ANDERSON, F.R.C.S., will preside.

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given :—

FEBRUARY 16.—LEWIS ATKINSON, "The Forthcoming Exhibition at Kimberley." The Hon. JOHN X. MERRIMAN, M.L.A., will preside. The paper will be illustrated by lantern slides. 8 p.m.

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru." 8 p.m.

APRIL 5.—The Rev. JOHN MCLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

FEBRUARY 11.—LORD LAMINGTON, "Recent Travels in Indo-China: From Siam to Tonquin." Lieut.-General Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., will preside. The paper will be illustrated by lantern slides.

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." The Right Hon. Sir JAMES CAIRD, K.C.B., will preside.

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets." Sir PHILIP CUNLIFFE-OWEN, K.C B., K.C.M.G., C.I.E., will preside.

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

LECTURE III.—FEBRUARY 8.—Transmission and distribution of electricity derived from lighting

circuits—Effect on load factor—Separate circuits for power—Distribution for street and other railways—Utilisation of water-power by electric transmission to a distance.

LECTURE IV.—FEBRUARY 15.—Generators of electricity by water-power and by steam obtained from destructors—General account of destructors—Hydraulic accumulators—Utilisation of local circumstances—Probable developments of electric distribution in the immediate future.

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.
February 29, March 7, 14, 21.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.
March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bateriology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 8... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. George Forbes, "Developments of Electrical Distribution." (Lecture III.)
Geographical, 44, Brown-street, Manchester. Prof. Boyd Dawkins, "Geology in relation to Geography."
Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Mr. Edwin T. Hall, "Building Legislation."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Henry Power, "The Movements of the Body, and how they are accomplished."

TUESDAY, FEB. 9... Royal Institution, Albemarle-street, W., 3 p.m. Professor Victor Horsley, "The Brain." (Lecture IV.)
Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Alfred Harper Curtis, "Gold-Quartz Reduction."
Photographic, 5A, Pall-mall East, S.W., 8 p.m. Annual Meeting.
Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. M. J. Walhouse, "Exhibition of Articles and Implements of every-day use among the Chin Tribes, on the Burmese Frontier." 2. Captain E. S. Hastings, "Exhibition of the Skull of a Chin Dacoit Leader." 3. Mr. J. R. Mortimer, "Exploration of Howe-hill Barrow, Duggleby, Yorkshire." 4. Dr. J. G. Garson, "Human Remains found in Howe-hill Barrow."
Colonial Institute, Whitehall Rooms, Hotel Métropole, Whitehall-place, S.W., 8 p.m. The Rev. Canon Beanlands, "British Columbia: a Problem of Colonial Development."

WEDNESDAY, FEB. 10... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. Price Edwards, "Burning Oils for Lighthouses and Lightships."
Geological, Burlington-house, 8 p.m. 1. Prof. J. Prestwich, "The Raised Beaches, 'Head,' or Rubble Drift in the South of England: their relation to the Valley Drifts and to the Glacial Period." 2. Messrs. B. N. Peach and John Horne, "The *Oleuellus* Zone in the North-West Highlands of Scotland."
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, FEB. 11... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Lord Lamington, "Recent Travels in Indo-China."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. William H. Cummings, "19th Century Music" (with vocal and instrumental illustsations).
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lancaster, "Some Recent Biological Discoveries."
Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by Mr. Alexander Siemens "Some Experimental Investigations of Alternate Currents," and Mr. W. H. Preece, "The Specification of Insulated Conductors for Electric Lighting and other purposes."
Institute of Architecture, Science, and Art, Dundee, 8 p.m. Mr. John Honeyman, "Glasgow Cathedral."
Mathematical, 22, Albemarle-street, W., 8 p.m.
Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. A. Haddon, "Glass Blowing for the Laboratory."

FRIDAY, FEB. 12... United Service Institution, Whitehall-yard, 3 p.m. Vice-Admiral Sir Edmund Fremantle, "The Training of our Seamen."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. G. J. Symons, "Rain, Snow, and Hail."
Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. H. B. Ransom, "Fly-Wheels and Governors."
Astronomical, Burlington-house, W., 8 p.m.
Junior Engineering Society, Westminster-palace-hotel, W., 8 p.m. Mr. Ernest G. Walker, "The Gas Engine."
Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, FEB. 13... Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Rev. G. F. Browne, "Early Christian Art." (Lecture I.—Ireland.)
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture I.)

CORRECTION.—Figures 1 and 3 in Dr. Edridge-Green's paper, on "Lovibond's Tintometer," were inadvertently misplaced in the last number of the *Journal* (pp. 214, 216). Figure 1 is absorption curve of the yellow glass, and should be numbered figure 3; figure 3 is absorption curve of the rose glass, and should be numbered figure 1.

Journal of the Society of Arts.

No. 2,047. Vol. XL.

FRIDAY, FEBRUARY 12, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. George Forbes, F.R.S., delivered the third lecture of his course on "Developments of Electrical Distribution," on Monday evening, 8th inst. The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

INDIA COMMITTEE.

A meeting of the India Committee was held on Thursday, at the offices of the Society of Arts. Present: Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E. (Chairman of the Committee); Lionel Robert Ashburner, C.S.I., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., General Sir George Chesney, K.C.B., C.S.I., C.I.E., S. Digby, William Digby, C.I.E., Colonel C. L. O. FitzGerald, C.B., W. S. Halsey, Robert Hardie, Charles Malcolm Kennedy, C.B., Lieut.-General J. Michael, C.S.I., Dadabhai Naoroji, Charles Pontifex, Lesly C. Probyn, Vincent J. Robinson, C.I.E., Alexander Rogers, Thomas H. Thornton, C.S.I., D.C.L., Stephen Wheeler, Sir Alexander Wilson, and Sir Henry Trueman Wood, Secretary of the Royal Commission.

Under date of the 27th August, 1891, Her Majesty was pleased to issue a Commission to the Council of the Society of Arts, authorising them to act as Commissioners for the Universal Exhibition, which, pursuant to an Act of Congress, and in accordance with a Proclamation made by the President of the United States of America, will be held at Chicago from May 1st to October 30th, 1893.

The Royal Commission are now prepared to receive applications from artists, manufacturers, and others desirous of taking part in the Exhibition, to afford them all necessary information, and to offer them all available facilities which they may desire for this purpose.

Such applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary, as above.

As the funds granted by H.M. Government will not suffice to defray all the expenses of the Section, it is necessary that they should be supplemented by payments from the exhibitors. A charge will therefore be made to each exhibitor, based on the amount of space occupied, and calculated on the following scale:—

	Per sq. ft. s.	d.
For spaces not exceeding 100 sq. ft. ..	5	0
For spaces exceeding 100 sq. ft. and not exceeding 200 sq. ft.	4	6
For spaces exceeding 200 sq. ft. and not exceeding 300 sq. ft.	4	0
For spaces exceeding 300 sq. ft. and not exceeding 500 sq. ft.	3	6
For spaces exceeding 500 sq. ft. and not exceeding 750 sq. ft.	3	0
For spaces exceeding 750 sq. ft. and upwards	2	6

The minimum charge will be £5.

It is not expected that the total receipts from all sources will more than suffice to defray the cost of an adequate representation of British industry; but should there be a sufficient surplus after the payment of all the costs of the Section, the Royal Commission will refund the balance *pro rata* with the amounts contributed by the several exhibitors. The amount produced by the payments of exhibitors will therefore be treated as a guarantee fund, to be expended if necessary, but if not, to be refunded to the contributors.

The Exhibition is situated in Jackson-park, within the southern limits of the city of Chicago. The principal buildings are devoted to the following main divisions:—(1) Fine Arts; (2) Manufactures and Liberal Arts; (3) Agricul-

ture; (4) Machinery; (5) Electricity; (6) Mines; (7) Transportation; (8) Horticulture. In all these, space has been allotted to Great Britain, though it is expected that the principal British Court will be that in the Building of Manufactures and Liberal Arts, since the privilege has been conceded to this country of massing all or most of its exhibits together, should such a course prove desirable.

Exhibitors' goods will be transmitted direct in bond to Chicago, where the usual Customs examination will be made. Goods for exhibition only will not be liable to duty, but on goods sold the usual rates will have to be paid. Goods can be sold in bond, at prices independent of the tariff, the duties being payable by the purchaser.

The American railroad companies propose to carry goods back from the Exhibition free, charging the usual rates for the outgoing journey. These rates, it may be noted, are low in comparison with those usual in European countries. It is hoped that special terms for Exhibition goods traffic may be obtained from the Atlantic steamship companies. Full information as to routes, traffic, rates, &c., will be provided in due course.

A general Official Catalogue will be published in English, French, German, and Spanish. A special catalogue will also be published for the British Section.

Exhibitions of live stock will be held, and prizes will be offered in connection with them. A special circular has been issued, giving information about these.

A limited quantity of steam and water power will be supplied gratuitously. Further supplies will be provided at a fixed rate. Countershafts, pulleys, belts, &c., must be provided by the exhibitor. Application for motive power must be made on special forms, which will be supplied on demand.

The general reception of articles at the Exhibition buildings will commence on November, 1892, and no articles will be admitted after April 10, 1893. Foundations for heavy machinery may be put in, and special constructive work commenced, as soon as the state of the grounds and the buildings permits.

Special regulations will be hereafter issued for the organisation of the International Juries.

The Royal Commission are informed that the contract labour laws of the United States will not prevent exhibitors from importing foreign labour, or from entering into binding contracts with their *employés*. Further information on this head will be supplied on application.

Every person who becomes an exhibitor in the British Section thereby agrees to be governed by the rules and regulations laid down by the Exhibition Executive, or by the Royal Commission through its executive officer.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, January 26th, 1892; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., Vice-President of the Society, in the chair.

The CHAIRMAN, in opening the proceedings, said:—Mr. William Morris needs no introduction to any English audience. But before he addresses you I must in a few words express my sense, and I am sure the sense of every one present, of the high honour he has done us in coming here this evening to open the sixth session of the Applied Art Section of the Society of Arts. It is not only as a poet and an art critic that he is one of the first Englishmen of the Victorian age. When the decorative arts of this country had about the middle of the present century gradually become denationalised, it was Mr. William Morris

"Who stemm'd the torrent of a downward age,"

and by the vigour of his characteristic English genius, cultivated in every phase of its activity to the highest sensibility, upraised these household arts again from the degradation of nearly two generations, and carried them to a perfection never before reached by them. And the influence of this, his distinctive work, will not die with him, for already he has succeeded in founding a national school of decorative designers, who, like Mr. Walter Crane and Mr. Lewis Day, approve his teaching to the judgment of their contemporaries, not by imitating his individual style and manner, but by faithfully following his example in seeking in English nature the ever quickening inspiration of English art. The way was, indeed, made straight before Mr. Morris and his followers by the revival in our national building style initiated by Pugin between 1837 and 1857. Owen Jones was the first to respond, as a designer, to the new impulse. But from his studies of the Alhambra and the overpowering impression made on him by the arts of India at the Great Exhibition of 1861, his mind became supersaturated with Orientalism, of which he and his best disciples remained, to the last, the slavish imitators. This has invariably led, in the history of Western art, to that repulsive vulgarisation of ornament, and that overloading with it of all forms, even architectural, which we indicate by

the term "rococo." We were saved from such a result in this century, at just the critical moment, by Mr. William Morris. A born decorator, he knew that it is decoration that animates architecture, and all form, with life and beauty. But being also a trained architect, he from the first recognised that ornament was but an accessory to construction of every kind, from the vessels turned on a potter's wheel to the grandest creations of the builders master art. Thus, and by his commanding intellectual and moral personal influence with his contemporaries, the future of English decorative design, in all its applications, was redeemed by Mr. Morris. I feel altogether unworthy of offering this expression of my appreciation of Mr. Morris's universally recognised claims on the consideration of his countrymen, but in receiving him here this evening I have felt it my duty to deliberately say what I have, on behalf of the Applied Art Section of the Society of Arts, for permanent record in the Society's *Journal*.

The paper read was—

THE WOODCUTS OF GOTHIC BOOKS.

By William Morris.

I shall presently have the pleasure of showing you in some kind of sequence a number of illustrations taken from books of the 15th and first years of the 16th centuries. But before I do so I wish to read to you a few remarks on the genesis and the quality of the kind of art represented by these examples, and the lessons which they teach us.

Since the earliest of those I have to show is probably not earlier in date than about 1420, and almost all are more than fifty years later than that, it is clear that they belong to the latest period of Mediæval art, and one or two must formally be referred to the earliest days of the Renaissance, though in spirit they are still Gothic. In fact, it is curious to note the suddenness of the supplanting of the Gothic by the neo-classical style in some instances, especially in Germany: *e.g.*, the later books published by the great Nuremberg printer, Koberger, in the fourteen-nineties, books like the "Nuremberg Chronicle," and the "Schatzbehalter," show no sign of the coming change, but ten years worn, and hey, presto, not a particle of Gothic ornament can be found in any German printed book, though, as I think, the figure-works of one great man, Albert Durer, were Gothic in essence.

The most part of these books, in fact all of them in the earlier days (the exceptions being mainly certain splendidly ornamented French books, including the sumptuous books of "Hours"), were meant for popular books: the great theological folios, the law books, the decretals, and such like of the earlier German printers, though miracles of typographical beauty, if ornamented at all, were ornamented by the illuminator, with the single exception of Gutenburg's splendid "Psalter," which gives us at once the first and the best piece of ornamental colour-printing yet achieved. Again, the dainty and perfect volumes of the classics produced by the earlier Roman and Venetian printers disdained the help of wood blocks, though they were often beautifully illuminated, and it was not till after the days of Jenson, the Frenchman who brought the Roman letter to perfection, it was not till Italian typography began to decline, that illustration by reproducible methods became usual; and we know that these illustrated books were looked upon as inferior wares, and were sold far cheaper than the unadorned pages of the great printers. It must be noted in confirmation of the view that the woodcut books were cheap books, that in most cases they were vernacular editions of books already printed in Latin.

The work, then, which I am about to show you has first the disadvantage of the rudeness likely to disfigure cheap forms of art in a time that lacked the resource of slippery plausibility which helps out cheap art at the present day. And secondly, the disadvantage of belonging to the old age rather than the youth or vigorous manhood of the Middle Ages. On the other hand, it is art, and not a mere trade "article;" and though it was produced by the dying Middle Ages, they were not yet dead when it was current, so that it yet retains much of the qualities of the more hopeful period; and in addition, the necessity of adapting the current design to a new material and method gave it a special life, which is full of interest and instruction for artists of all times who are able to keep their eyes open.

All organic art, all art that is genuinely growing, opposed to rhetorical, retrospective, or academical art, art which has no real growth in it, has two qualities in common: the epical and the ornamental; its two functions are the telling of a story and the adornment of a space or tangible object. The labour and ingenuity necessary for the production of anything that claims our attention as a work of art are wasted, if they are employed on anything else than these two aims. Mediæval art, the result of a long unbroken series of tradition, is preeminent for its grasp of these two functions, which, indeed, interpenetrate then more than

in any other period. Not only is all its special art obviously and simply beautiful as ornament, but its ornament also is vivified with forcible meaning, so that neither in one or the other does the life ever flag, or the sensuous pleasure of the eye ever lack. You have not got to say, Now you have your story, how are you going to embellish it? Nor, Now you have made your beauty, what are you going to do with it? For here are the two together, inseparably a part of each other. No doubt the force of tradition, which culminated in the Middle Ages, had much to do with this unity of epical design and ornament. It supplied deficiencies of individual by collective imagination (compare the constantly recurring phrases and lines in genuine epical or ballad poetry); it ensured the inheritance of deft craftsmanship and instinct for beauty in the succession of the generations of workmen; and it cultivated the appreciation of good work by the general public. Now-a-days artists work essentially for artists, and look on the ignorant layman with a contempt, which even the necessity of earning a livelihood cannot force them wholly to disguise. In the times of art, they had no one but artists to work for, since everyone was a potential artist.

Now, in such a period, when written literature was still divine, and almost miraculous to men, it was impossible that books should fail to have a due share in the epical-ornamental art of the time. Accordingly, the opportunities offered by the pages which contained the wisdom and knowledge of past and present times were cultivated to the utmost. The early Middle Ages, beginning with the wonderful caligraphy of the Irish MSS., were, above all times, the epoch of *writing*. The pages of almost all books, from the 8th to the 15th century, are beautiful, even without the addition of ornament. In those that are ornamented without pictures illustrative of the text, the eye is so pleasured, and the fancy so tickled by the beauty and exhaustless cheerful invention of the illuminator, that one scarcely ventures to ask that the tale embodied in the written characters should be further illustrated. But when this is done, and the book is full of pictures, which tell the written tale again with the most conscientious directness of design, and as to execution with great purity of outline and extreme delicacy of colour, we can say little more than that the only work of art which surpasses a complete Mediæval book is a complete Mediæval building. This must be said, with the least qualification, of the books of from about 1160 to 1300. After this date, the work loses, in purity and simplicity, more than it gains in pictorial qualities, and, at last, after the middle of the 15th century, illuminated books lose much of their individuality on the ornamental side; and, though they are still beautiful, are mostly only redeemed from commonplace when the miniatures in them are excellent.

But here comes in the new element, given by the invention of printing, and the gradual shoving out of the scribe by the punch-cutter, the typefounder, and the printer. The first printed characters were as exact reproductions of the written ones as the new craftsmen could compass, even to the extent of the copying of the infernal abbreviations which had gradually crept into manuscript; but, as I have already mentioned, the producers of serious books did not at first supply the work of the illuminator by that of the woodcutter, either in picture work or ornament. In fact the art of printing pictures from wood blocks is earlier than that of printing books, and is undoubtedly the parent of book illustration. The first woodcuts were separate pictures of religious subjects, circulated for the edification of the faithful, in existing examples generally coloured by hand, and certainly always intended to be coloured. The earliest of these may be as old as 1380, and there are many which have been dated in the first half of the 15th century; though the dates are mostly rather a matter of speculation. But the development of book illustration proper by no means put an end to their production. Many were done between 1450 and 1490, and some in the first years of the 16th century; but the earlier ones only have any special character in them. Of these, some are cut rudely and some timidly also, but some are fairly well cut, and few so ill that the expression of the design is not retained. The design of most of these early works is mostly admirable, and as far removed from the commonplace as possible; many, nay most of these cuts, are fine expressions of that passionate pietism of the Middle Ages which has been somewhat veiled from us by the strangeness, and even grotesqueness which has mingled with it, but the reality of which is not doubtful to those who have studied the period without prejudice. Amongst these may be cited a design of Christ being pressed in the wine press, probably as early as the end of the 14th century, which may stand without disadvantage beside a fine work of the 13th century.

FIG. 1.—FLEMISH SCHOOL. FROM "THE LIFE OF CHRIST." ANTWERP: GHERAERT LEEUW, 1487.
[Size of Original.]

The next step towards book illustration brings us to the block-books, in which the picture-cuts are accompanied by a text, also cut on wood; the folios being printed by rubbing off on one side only. The subject of the origin of the most noteworthy of these books, the "Ars Moriendi," the "Lord's Prayer," the "Song of Solomon," the "Biblia Pauperum," the "Apocalypse," and the "Speculum Humanæ Salvationis," has been debated, along with the question of the first printer by means of moveable types, with more acrimony than it would seem to need. I, not being a learned person, will not add one word to the controversy; it is enough to say that these works were done somewhere between the years 1430 and 1460, and that their style was almost entirely dominant throughout the Gothic period in Flanders and Holland, while it had little influence on the German wood-cutters. For the rest, all these books have great merit as works of art; it would be difficult to find more direct or more poetical rendering of the events given than those of the "Speculum Humanæ Salvationis;" or more elegant and touching designs than those in the "Song of Solomon." The cuts of the "Biblia Pauperum" are rougher, but full of vigour and power of expression. The "Ars Moriendi" is very well drawn and executed, but the subject is not so interesting. The "Apocalypse" and the "Lord's Prayer" are both of them excellent, the former being scarcely inferior in design to the best of the Apocalypse picture MSS. of the end of the 13th century.

We have now come to the wood-cuts which ornament the regular books of the Gothic period, which began somewhat timidly. The two examples in Germany and Italy, not far removed from each other in date, being the "Historie von Joseph, Daniel, Judith, and Esther," printed by Albrecht Pfister, at Bamberg, in 1462; and the "Meditations of Turrecremata (or Torquemada)," printed at Rome by Ulric Hahn, in the year 1467, which latter, though taken by the command of the Pope from the frescoes of a Roman Church (Sta. Maria Sopra Minerva) are as German as need be, and very rude in drawing and execution, though not without spirit.

But, after this date, the school of wood-carving developed rapidly; and, on the whole, Germany, which had been very backward in the art of illumination, now led the new art.

The main schools were those of Ulm and Augsburg, of Maintz, of Strasburg, of Basel, and of Nuremburg, the latter being the later. The examples which I shall presently have the pleasure of showing you are wholly of the first and the last, as being the most representative, Ulm and Augsburg of the earlier style, Nuremburg of the later. But I might mention, in passing, that some of the earlier Basel books, notably Bernard Richel's "Speculum Humanæ Salvationis," are very noteworthy; and that, in the fourteen-eighties, there was a school at Maintz that produced, amongst other books, a very beautiful "Herbal," and Breydenbach's "Peregrinatio," which, amongst other merits, such as actual representations of the cities on the road to the Holy Land, must be said to contain the best executed woodcuts of the Middle Ages. Of course, there were many other towns in Germany which produced illustrated books, but they may be referred in character to one or other of these schools.

In Holland and Flanders there was a noble school of wood-cutting, delicately decorative in character, and very direct and expressive, being, as I said, the direct descendant of the block-books. The name of the printer who produced most books of this school was Gerard Leeuw (or Lion), who printed first at Gouda, and afterwards at Antwerp. But Colard Mansion, of Bruges, who printed few books, and was the master of Caxton in the art of printing, turned out a few very fine specimens of illustrated books. One of the most remarkable illustrated works published in the Low Countries—which I mention for its peculiarity—is the "Chevalier Deliberé" (an allegorical poem on the death of Charles the Rash), and I regret not being able to show you a slide of it, as it could not be done satisfactorily. This book, published at Schiedam in 1500, decidedly leans towards the French in style, rather than the native manner deduced from the earlier block-books.

France began both printing and book illustration somewhat late, most of its important illustrated works belonging to a period between the years 1485 and 1520; but she grasped the art of book decoration with a firmness and completeness very characteristic of French genius; and, also, she carried on the Gothic manner later than any other nation. For decorative qualities, nothing can excel the French books, and many of the picture-cuts, besides their decorative merits, have an additional interest in the romantic quality which they introduce: they all look as if they might be illustrations to the "Morte D'Arthur" or "Tristram."

In Italy, from about 1480, onward book

illustrations became common, going hand-in-hand with the degradation of printing, as I said before. The two great schools in Italy are those of Florence and Venice. I think it must be said that, on the whole, the former city bore away the bell from Venice, in spite of the famous Aldine "Polyphilus," the cuts in which, by the way, are very unequal. There are a good many book illustrations published in Italy, I should mention, like those to Ulric Hahn's "Meditations of Turrecremata," which are purely German in style; which is only to be expected from the fact of the early printers in Italy being mostly Germans.

I am sorry to have to say it, but England cannot be said to have a school of Gothic book illustration; the cuts in our early printed books are, at the best, French or Flemish blocks pretty well copied; at the worst, they are very badly copied. This lamentable fact is curious, considered along with what is also a fact: that in the 13th and 14th centuries the English were, on the whole, the best book decorators.

I have a few more words to say yet on the practical lessons to be derived from the study of these works of art; but before I say them, I will show you, by your leave, the slides taken from examples of these woodcuts. Only I must tell you first, what doubtless many of you know, that these old blocks were not produced by the graver on the end section of a piece of fine-grained wood (box now invariably), but by the knife on the plank section of pear-tree or similar wood—a much more difficult feat when the cuts were fine, as, *e.g.*, in Lützelberger's marvellous cuts of the "Dance of Death."

Mr. Morris then showed a series of lantern slides, which he described as follows:—

1. This is taken from the "Ars Moriendi," date about 1420. You may call it Flemish or Dutch, subject to raising the controversy I mentioned just now.

2. The "Song of Solomon," about the same date.

3. From the first illustrated book of the Ulm school. The Renowned and Noble Ladies of Boccaccio. It begins with Adam and Eve. The initial letter is very characteristic of the Ulm school of ornament. The trail of the serpent forms the S, and in the knots of the tail are little figures representing the seven deadly sins.

4. Another page from the same book. "Ceres and the Art of Agriculture." One of the great drawbacks to wood block printing in those times was the weakness of the presses. Their only resource was to print with the paper very wet, and with very soft packing, so that the block went well into the paper; but many books, and this amongst others, have suffered much from this cause.

5. Another page of the same book. The date is 1473.

6. This is from an Augsburg book. "Speculum Humanæ Vitæ," written by a Spanish bishop, which was a great favourite in the Middle Ages. It gives the advantages and disadvantages of all conditions of life. This block contains a genealogical tree of the Hapsburg family, and is an exceedingly beautiful piece of ornamental design very well cut.

7. From the same book; representing not the "Five Alls," with which you are familiar, but the "Four Alls; the gentleman, the merchant, the nobleman, and the poor man, who is the support of the whole lot, with his toes coming through his shoes. This is a fine specimen of the printing of Gunther Zeiner. The initial letters are very handsome in all these Augsburg books.

8. There is a picture of the Unjust Lawyer, from the same book, taking money from both sides. The date of this book is about 1475.

9. From "Æsop's Fables," a reproduction of the "Ulm Æsop," by Antony Sorg, of Augsburg (but the pictures are printed from the same blocks), the "Fly on the Wheel," and the "Jackdaw and Peacock." These designs for the Æsop pictures went all through the Middle Ages, with very little alteration.

10. "King Stork and King Log," from the same book.

11. This is from the Fable-book of Bidpay, by Conrad Dinckmuth, who carried on the early glories of the Ulm school in a later generation; about 1486.

12. The Parrot in a Cage, with the ladies making a sham storm to cause the poor bird to be put to death. Dinckmuth did some very remarkable work: one of the best of which was a German translation of the "Eunuchus" of Terence; another the "Chronicle of the Swabians."

13. The "Schatzbehalter," published by Koburger, of Nuremburg; 1491. Although so late, there is no trace of any classical influence in the design. The architecture, for instance, is pure late German architecture.

14. From the same book, "Joshua Meeting the Angel," and "Moses at the Burning Bush."

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y a deux ſens. Ceſt aſſauoir. le ſens litte/
ral. ⁊ le ſens eſpirituel. Deſquelx lung q̄
eſt eſpirituel eſt diuiſe en trois autres.
Dont le premier eſt le ſens allegorique. le
quel monſtre les miſteres quon doit entē
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re pour bien nous conduire et gouuerner.
Et le tiers eſt anagogique / ceſt adire diui
Et selōd tel ſens eſt leſcripture expoſee
touchant les choſes celeſtielles et diuines
Mais le ſens litteral ou hiſtorique mō/
ſtre tant ſeulement liſtoire selōd la lettre
ſans gloſe / ne quelque expoſitiō. Leſq̄lx
quatre ſens deſſuſditz cōme dit Francois
de marones ſont appropriez aux quatre do
cteurs de legliſe. Car ſainct auguſti fuſt
anagogique. Interpretāt la ditte saincte
eſcripture selond les choſes haultes ⁊ diui
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apaulinus: que ſainct auguſtin voloit cō/
me vng aigle par les ſūmitez des montai
gnes / ſe efforcant de prendre et cueillir les
pommes qui eſtoient plus haultes ſur
larbre. Ceſt adire le ſēs plus difficille. Et
en leſſāt les choſes faciles aux autres do/
cteurs. Sainct Jerome. ii^e. docteur de le
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litteral. Sainct ambroiſe fuſt allegoriq̄.
Expoſant la saincte eſcripture touchant
les miſteres que nous deuons croire. Et
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En ceſte propoſition In principio a

FIG. 2.—FRENCH SCHOOL. FROM "LA MER DES HISTOIRES." PARIS: PIERRE LE ROUGE, 1488.
[Size of Original, 10 in. by 14⅝ in.]

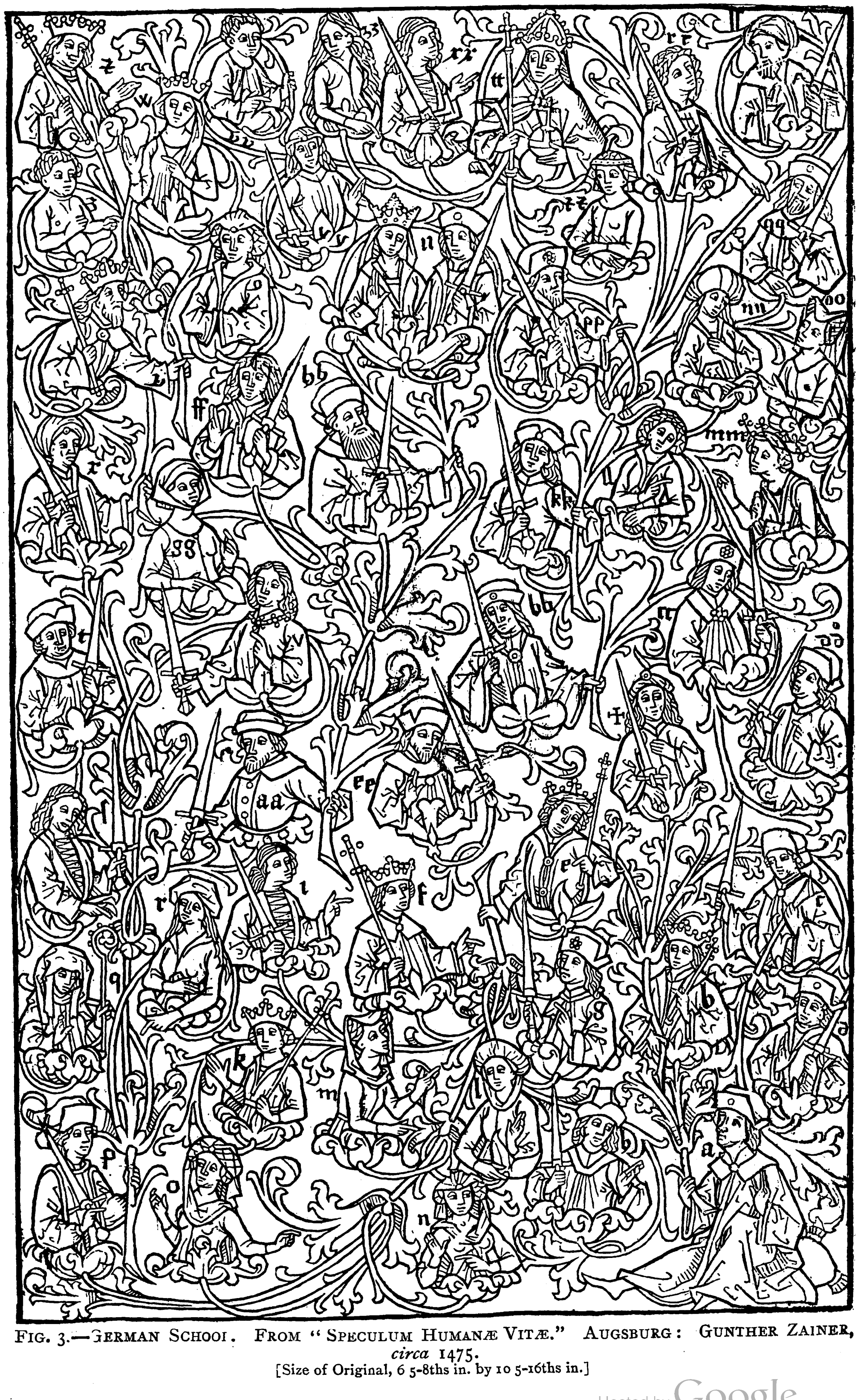


FIG. 3.—GERMAN SCHOOL. FROM "SPECULUM HUMANÆ VITÆ." AUGSBURG: GUNTHER ZAINER, *circa* 1475.

[Size of Original, 6 5-8ths in. by 10 5-16ths in.]

15. A page, or part of a page, from the celebrated *Nuremberg Chronicle*, printed by Koburger in 1493. This is in a way an exception to the rule of illustrated books being in the vernacular, as it is in Latin; but there is also a German edition.

16. Another specimen of the same book.

17. From a curious devotional book, "Der Seusse," printed by Antony Sorg, at Augsburg; about 1485,

18. Another page, which shows the decorative skill with which they managed their diagram pictures.

19. An example of the Flemish school, and characteristic of the design of white on black, which is so often used both by the Florentine and the Flemish wood-cutters. It is from a life of Christ, published by Gerard Leeuw in 1487.

20. Another page from the same book. There are certainly two artists in this book, and the one on the left appears to be the more pictorial of the two; though his designs are graceful, he is hardly as good as the rougher book illustrator. Gerard Leeuw had a very handsome set of initial letters, a kind of ornament which did not become common until after 1480.

21. Another one from the same book.

22. From another Flemish book, showing how the style runs through them all. St. George and the Dragon; from "A Golden Legend," 1503.

23. One of French series, from a very celebrated book called "La Mer des Histoires." It begins the history of France a little before the deluge. It is a most beautiful book, and very large. One would think these borders were meant to be painted, as so many "Books of Hours" were, but I have never seen a copy which has had the borders painted, though, as a rule, when the borders are meant to be painted, it is not common to find one plain.

24. Another page from the same book; but the slide does not do justice to it. I will here mention that one failing of the French publishers was to make one picture serve for several purposes. The fact is, they were more careful of decoration than illustration.

25. Another French book by a French printer, the "Aubre des Batailles," which illustrates that curious quality of romance which you find in the French pictures. It is true that many of these cuts were not made for this book; in fact, they were done for another edition of the Chevalier Deliberé, the Flemish edition of which I have mentioned before, for some have that name on them.

26. Another from the same book.

27. Another good example of the French decorative style. It is from Petrarch's "Remedy of either Fortune." This is the author presenting his book to the king, and is often used in these French books.

28. From another French book of about the same date (the beginning of the 16th century), "The Shepherd's Calendar," of which there were a great number of English editions, even as late as 1656, the cuts being imitated from these blocks.

29. A page from one of the beautiful "Books of Hours," which were mostly printed on vellum, every page of which is decorated more or less with this sort of picture. Here is the calendar, with the signs of the Zodiac, the work of the months, the saints that occur in it, and games and sports; on the other side is the Sangraal. This book is throughout in the same style—wholly Gothic. It was printed in 1498, and about twenty years after these service-books became very much damaged by having Renaissance features introduced from German artists of the time.

30. Another page from the same book. The Resurrection, and the raising of Lazarus are the principal subjects.

31. Nominally an Italian woodcut; the book was printed at Milan, but this cut is probably of German design, if not execution.

32. From a very beautiful book in the Florentine style. One of the peculiarities is the copious use of white out of black.

33. Another from the same—"The Quatre reggio," 1508.

34. Another, very characteristic of the Florentine style, with its beautiful landscape back ground.

35. This is one in which the ornament has really got into the Renaissance style. It is a sort of "Lucky Book," with all sorts of ways of finding your fortune, discovering where your money has gone, who is your enemy, and so on. One of the Peschia books, actually printed at Milan, but of the Venetian school.

36. From a book of the Venetian style, about the same date. I show it as an example of the carefulness and beauty with which the artists of the time combined the border work with the pictures. There is something very satisfactory in the proportion of black and white in the whole page.

Now you have seen my examples, I want once more to impress upon you the fact that these designs, one and all, while they perform their especial function—the office of telling a

tale—never forget their other function of decorating the book of which they form a part; this is the essential difference between them and modern book illustrations, which I suppose make no pretence at decorating the pages of the book, but must be looked upon as black and white pictures which it is convenient to print and bind up along with the printed matter. The question, in fact, which I want to put to you is this, Whether we are to have books which are beautiful as books; books in which type, paper, woodcuts, and the due arrangement of all these are to be considered, and which are so treated as to produce a harmonious whole, something which will give a person with a sense of beauty real pleasure whenever and wherever the book is opened, even before he begins to look closely into the illustrations; or whether the beautiful and inventive illustrations are to be looked on as separate pictures embedded in a piece of utilitarianism, which they cannot decorate because it cannot help them to do so. Take as an example of the latter, Mr. Fred. Walker's illustrations to "Philip" in the "Cornhill Magazine," of the days when some of us were young, since I am inclined to think that they are about the best of such illustrations. Now they are part of Thackeray's story, and I don't want them to be in any way less a part of it, but they are in no respect a part of the tangible printed book, and I do want them to be that. As it is, the mass of utilitarian matter in which they are embedded is absolutely helpless and dead. Why it is not even ugly, at least not vitally ugly.

Now the reverse is the case with the books from which I have taken the examples which you have been seeing. As things to be looked at they are beautiful taken as a whole; they are alive all over, and not merely in a corner here and there. The illustrator has to share the success and the failure, not only of the wood cutter, who has translated his drawing, but also of the printer and the mere ornamentalist, and the result is that you have a book which is a visible work of art.

You may say that you don't care for this result, that you wish to read literature and to look at pictures; and that so long as the modern book gives you these pleasures you ask no more of it; well, I can understand that, but you must pardon me if I say that your interest in books in that case is literary only, and not artistic, and that implies, I think, a partial crippling of the faculties; a misfortune which no one should be proud of.

However, it seems certain that there is growing up a taste for books which are visible works of art, and that especially in this country, where the printers, at their best, do now use letters much superior in form to those in use elsewhere, and where a great deal of work intending to ornament books reasonably is turned out; most of which, however, is deficient in some respect; which, in fact, is seldom satisfactory unless the whole page, picture, ornament, and type is reproduced literally from the handiwork of the artist, as in some of the beautiful works of Mr. Walter Crane.

But this is a thing that can rarely be done, and what we want, it seems to me, is, not that books should sometimes be beautiful, but that they should generally be beautiful; indeed, if they are not, it increases the difficulties of those who would make them sometimes beautiful immensely. At any rate, I claim that illustrated books should always be beautiful, unless, perhaps, where the illustrations are present rather for the purpose of giving information than for that of giving pleasure to the intellect through the eye; but surely, even in this latter case, they should be reasonably and decently good-looking.

Well, how is this beauty to be obtained? It must be by the harmonious co-operation of the craftsmen and artists who produce the book. First, the paper should be good, which is a more important point than might be thought, and one in which there is a most complete contrast between the old and the modern books; for no bad paper was made till about the middle of the 16th century, and the worst that was made even then was far better than what is now considered good. Next, the type must be good, a matter in which there is more room for excellence than those may think who have not studied the forms of letters closely. There are other matters, however, besides the mere form of the type which are of much importance in the producing of a beautiful book, which, however, I cannot go into to-night, as it is a little beside my present subject. Then, the mere ornament must be good, and even very good. I do not know anything more dispiriting than the mere platitudes of printers' ornaments—trade ornaments. It is not uncommon now-a-days to see handsome books quite spoiled by them—books in which plain, unadorned letters would have been far more ornamental.

Then we come to the picture woodcuts. And here I feel I shall find many of you differing

from me strongly; for I am sure that such illustrations as those excellent black and white pictures of Fred. Walker could never make book ornaments. The artist, to produce these satisfactorily, must exercise severe self restraint, and must never lose sight of the page of the book he is ornamenting. That ought to be obvious to you, but I am afraid it will not be. I do not think any artist will ever make a good book illustrator, unless he is keenly alive to the value of a well-drawn line, crisp and clean, suggesting a simple and beautiful *silhouette*. Anything which obscures this, and just to the extent to which it does obscure it, takes away from the fitness of a design as a book ornament. In this art vagueness is quite inadmissible. It is better to be wrong than vague in making designs which are meant to be book ornaments.

Again, as the artists' designs must necessarily be reproduced for this purpose, he should never lose sight of the material he is designing for. Lack of precision is fatal (to take up again what I have just advanced) in an art produced by the point of the graver on a material which offers just the amount of resistance which helps precision. And here I come to a very important part of my subject, to wit, the

Fig. 4.—Italian School. The Descent of Minerva. From the Quatrereggio. Florence, 1508.
[Size of Original.]

relation between the designer and the wood-engraver; and it is clear that if these two artists do not understand one another, the result must be failure; and this understanding can never exist if the wood-engraver has but to cut servilely what the artist draws carelessly. If any real school of wood-engraving is to exist again, the wood-cutter must be an artist translating the designer's drawing. It is quite pitiable to see the patience and ingenuity of such clever workmen, as some modern wood-cutters are, thrown away on the literal reproduction of mere meaningless scrawl. The want of logic in artists who will insist on such work is really appalling. It is the actual touches of the hand that give the speciality, the final finish to a work of art, which carries out in one material what is designed in another; and for the designer to ignore the instrument and material by which the touches are to be done, shows complete want of understanding of the scope of reproducible design.

I cannot help thinking that it would be a good thing for artists who consider designing part of their province (I admit there are very few such artists) to learn the art of wood-engraving, which, up to a certain point, is a far from difficult art; at any rate for those who have the kind of eyes suitable for the work. I do not mean that they should necessarily

always cut their own designs, but that they should be able to cut them. They would thus learn what the real capacities of the art are, and would, I should hope, give the executant artists genuine designs to execute, rather than problems to solve. I do not know if it is necesssary to remind you that the difficulties in cutting a simple design on wood (and I repeat that all designs for book illustrations should be simple) are very much decreased since the 15th century, whereas instead of using the knife on the plank section of the wood, we now use the graver on the end section. Perhaps, indeed, some of you may think this simple wood cutting contemptible, because of its ease; but delicacy and refinement of execution are always necessary in producing a line, and this is not easy, nay it is not possible to those who have not got the due instinct for it; mere mechanical deftness is no substitute for this instinct.

Again, as it is necessary for the designer to have a feeling for the quality of the final execution, to sympathise with the engraver's difficulties, and know why one block looks artistic and another mechanical; so it is necessary for the engraver to have some capacity for design, so that he may know what the designer wants of him, and that he may be able to translate the designer, and give him a genuine and obvious *cut* line in place of his *pencilled* or *penned* line without injuring in any way the due expression of the original design.

Lastly, what I want the artist—the great man who designs for the humble executant—to think of is, not his drawn design, which he should look upon as a thing to be thrown away when it has served its purpose, but the finished and duly printed ornament which is offered to the public. I find that the executants of my humble designs always speak of them as "sketches," however painstaking they may be in execution. This is the recognised trade term, and I quite approve of it as keeping the "great man" in his place, and showing him what his duty is, to wit, to take infinite trouble in getting the finished work turned out of hand. I lay it down as a general principle in all the arts, where one artist's design is carried out by another in a different material, that doing the work twice over is by all means to be avoided as the source of dead mechanical work. The "sketch" should be as slight as possible, *i.e.*, as much as possible should be left to the executant.

A word or two of recapitulation as to the practical side of my subject, and I have done. An illustrated book, where the illustrations are more than mere illustrations of the printed text, should be a harmonious work of art. The type, the spacing of the type, the position of the pages of print on the paper, should be considered from the artistic point of view. The illustrations should not have a mere accidental connection with the other ornament and the type, but an essential and artistic connection. They should be designed as a part of the whole, so that they would seem obviously imperfect without their surroundings. The designs must be suitable to the material and method of reproduction, and not offer to the executant artist a mere thicket of unnatural difficulties, producing no result when finished, save the exhibition of a *tour de force*. The executant, on his side, whether he be the original designer or someone else, must understand that his business is sympathetic translation, and not mechanical reproduction of the original drawing. This means, in other words, the designer of the picture-blocks, the designer of the ornamental blocks, the wood-engraver, and the printer, all of them thoughtful, painstaking artists, and all working in harmonious co-operation for the production of a work of art. This is the only possible way in which you can get beautiful books.

DISCUSSION.

Mr. LEWIS DAY expressed his thorough agreement with Mr. Morris, and the pleasure it had afforded him to hear the paper. There were plenty of competent lecturers who could talk very well on any subject under the sun, but it was a very different thing to hear a man speak straight out from his heart on a subject which he had made thoroughly his own. A comparison had been drawn between the old printing and the new. He did not pretend to be learned with regard to old printing, and could not, therefore, attempt to criticise anything which had been said about it; he was content to enjoy the old work. But really the two things were hardly to be compared; the old books were few, produced by the few, and for the few; whilst the new were for the many, done by the many, and there were a great many too many of them. He sympathised entirely with Mr. Morris when he spoke of book illustration as it should be, but doubted very much if that ever would be. He believed in many impossibilities, but not in that one, and he should really like to know how far Mr. Morris himself believed in it. Mr. Morris had lately been printing books himself, having designed type for the purpose, and very beautiful work he had turned out. But that formed

only, as it were, a little oasis in the wilderness of general printing, and did not go far towards fertilising the dead level of dreary monotonous trade-work all around. One obvious reason why the new work was so different from the old had been referred to by Mr. Morris when he spoke of sketches and designs. Now-a-days, if a man had to make designs for book illustration, he was, first of all, asked to send in rough suggestions; then he had to make what are called "finished" drawings of such as were approved, to be again submitted to the publisher and his head man, and all sorts of people who did not know anything about it. Even when they did not take what good there was in a thing out of it, and produce it vilely, they were pretty sure to insist upon all sorts of preliminary business, by which the heart was taken out of the artist. He should like to know if Mr. Morris really had any hope of general improvement in book illustration; it was only faith that worked miracles, and this would certainly be a miracle. The man who believed in it might accomplish it; and if anybody could do it Mr. Morris could.

Mr. F. S. ELLIS said he also entirely agreed with all that Mr. Morris had said, and he had the greatest hopes of a good result from the efforts Mr. Morris had lately made. Having been only a publisher—though he was one no longer, and not in any sense an artist—he could only look at the matter from his own point of view. He thought publishers would stand very much in their own light if they interfered with an artist, when they had found one capable of illustrating their books in a proper manner. If books were sensibly and properly illustrated, he felt sure the public would be only too thankful to get them, and the whole system would soon undergo a very material improvement.

Mr. MATTHEW WEBB suggested that there was a practical difficulty in producing woodcuts, which should combine the two qualities of illustrating the story and at the same time ornamenting the book. For ornamental purposes there should be very little light and shade, but their absence would materially interfere with the story-telling power.

Mr. HUGH STANNUS said his knowledge of this subject began just where the paper left off. Once or twice in his life he had been able to purchase some of the fine old Italian woodcut books, dating from the beginning to the middle of the 16th century, which was just after the period Mr. Morris had dealt with. He could only hope that he would carry on the subject, which was a most interesting and important one, and give them the result at some future meeting.

Mr. J. SACHS thought wood engravers should be encouraged to develop their birth-right, which was the production of texture. There was hardly any art in black and white which could produce texture like wood engraving; it could be seen in any common catalogue. He must take exception to the remark that wood engraving could be learned easily. He had been an apprentice himself, and had had many apprentices, and he was prepared to say that no one could produce even a sound line without three or four months steady application. It had often been said that Albert Durer and Holbein engraved their own blocks, which was absurd. They evidently employed block cutters to cut the drawings which they had made.

The CHAIRMAN, in moving a vote of thanks to Mr. Morris, said he could not offer any critical obser- vaations on the subject of the paper, but there were one or two points connected with it which specially interested him. When Mr. Morris was considering the date of some of the blocks it struck him that the plants and trees represented would, in some cases, furnish a clue. There was one block, said to be Italian, which Mr. Morris thought must have been cut by a German. He should say most probably, for the plant represented seemed to him to be the mountain ash. In the Florentine engraving of 1508, which followed, the tree was, apparently, a Lombardy poplar, and if so, it was interesting, because the tree was introduced from America, and the block showed that it had already become common in Italy at that date. Turning to woodcuts in modern books, he could not help referring to Walter Crane's "Grimm's Tales," one of the best illustrated books he had seen for a long time. He always purchased ten or twelve copies of all Mr. Crane's cheaper books, and he had distributed that one very widely. He might perhaps be allowed to say, quite incidentally, that he did not share Mr. Morris's prejudice against the unjust judge who took money from both parties to any suit he was trying. In the East he was considered the perfect judge who took a bribe from each litigant, and returned it to the unsuccessful one, who then felt satisfied that the judge had done everything possible for him, but was unable to decide in his favour. In conclusion, he wished the proprietors of illustrated papers would do more for the cause of the good decoration of books. They certainly might lead the way in this branch of the revival of national taste. He had for years been carrying on a correspondence with the managers of some of these papers, in the hope of inducing them to give up advertising on the backs of their best illustrations, and so completely spoiling them. The manager of the *Graphic* wrote to him a year or two ago, to say that his criticisms had been taken seriously to heart, and that when the existing contracts ran out they would try to avoid the pernicious practice; but they had not fulfilled their promise. Probably the receipts from the advertisers were too great a temptation for the proprietors. The practice was more general and obtrusive than ever, and he had in consequence given up binding the weekly illustrated papers, for in book form they were now offensive to the eye. He was on the free list of the

Graphic, and it might seem ungracious to look a gift horse in the mouth; but it was in the interest of the illustrated papers themselves that he raised this protest, for such sordid "double-dealing" has always proved the damnation of art.

The vote of thanks having been carried unanimously,

Mr. MORRIS, in reply, said it was a pity that the contrary view to his own had not been put forward by some one, as there was a good deal to be said *pro* and *con*. What Mr. Sachs had said about texture was very true, but it applied after all to a particular kind of wood-cutting, not to that which he was thinking of as being suitable to the ornamentation of a page. He remembered a lecturer showing a very beautiful slide of Bewick's starling, which looked exceedingly handsome, but it had no relationship whatever to the type of the page on which it appeared, or rather the type had no relationship to it, and the result was that the starling did not make an ornament to the page, and one would prefer to have a separate proof of the starling. That was a strong case, because he yielded to no one in his admiration for Bewick's work, especially when it was employed on fur and feathers. But this view of texture may be carried so far as to apply it to the mere presentation of outline; since it made all the difference in the world whether those lines were cut nice and round, and sweet, or whether they were reduced to a straight needle point on the one hand, or, on the other hand were chopped out and were made edgy and sour. He did not propose to go into any battle of the styles, but the page of the book, the type, and the woodcut ought to go together. If it were necessary to have such woodcuts as Mr. Fred Walker's illustrations to "Philip," the type ought to go with them, to be of the same style. But though this might be possible, it was unnatural, because the essential character of a book was that it was stamped; printers called the types stamps, and the woodcuts were stamps. There ought to be that same kind of clearness and distinctness—that absence of vagueness which you got in the stamping of a coin. Mr. Webb said there might be a difficulty in reconciling the story-telling function of a woodcut with its ornamental function, and no doubt that was true; but it seemed to him that it was just that kind of difficulty or limitation which made an art worth following. If there were no difficulty in carrying out a work of art in any special material, instead of learning to be an artist in pottery, or glass, or wood-cutting, why not follow the most simple and direct form of art, which gave the advantages of all others, not perhaps in the easiest, but in the fullest, way—that of oil painting. But that was not what was wanted. Oil painting might be the most important of all the arts, though he was not quite sure about that; but nevertheless you wanted other arts as well. The woodcutter or the artist had no more right to grumble at the conditions under which he worked than the poet had at having to write in rhyme instead of prose. If he wanted to write prose he could do so. As a matter of fact, if books were largely ornamented in this way, some *modus vivendi* would be found between the ornamental and the story-telling capacity of the art; a school would grow up which would have its own due and proper conventions, under which it would work with perfect ease. The question raised by Mr. Day as to what hope there was for an improvement in book illustration and ornamentation, was really whether it could be hoped for as an ordinary and general thing. He did see certain difficulties, which mostly reduced themselves in the long-run into commercial ones, with which he was not bound to deal on the present occasion. If people chose, they could have such books in very large measure, but no doubt the commercial difficulty would put a stopper on many attempts to decorate books properly. He thoroughly sympathised with what Mr. Day said about the publisher and his man interfering with the artist. The publisher ought to select the artist, tell him what the book was, and the subject required, and let him do his best. But there was one thing in favour of the possibilty of having beautiful books; they were self-contained. If he were asked whether it were possible to have buildings generally good in the present day, he should say, no; but, in the case of books, which were self-contained things, he would say yes. There were not the same difficulties with a book as with many other articles of commerce. The first thing necessary was to have a certain number of artists who had an intense desire to produce work suitable for book ornament; and those artists would, in some way, force the public to give them an opportunity for producing those books. He threw the whole burden really on the group of which he was a humble member, the artists themselves; the public could only take such books as were offered them. The publishers' part was to open their purse as widely as possible, not be afraid to spend a good deal of money on a good book, though they only sold a few copies. Finally, even if books were not beautiful, they migh be made tolerably good looking. Perhaps some little advance had been made. The principal difficulty in getting a cheap book to look well was the paper, but if people would only turn their attention to this matter, they could easily get paper much better for its purpose than what was now considered good paper—paper which would show on the surface of it that it was common paper, but would not be disagreeable to handle or read, and would not be of that horrible shiny character, and look as if you could rub it all to pieces, which, in fact, you could. Some books you could not even carry comfortably from one end of a room to the other, on account of the extra weight of the adulterants necessary for that kind of paper. He had had in his hand a moderate sized book, a royal 8vo., which weighed as heavy as the biggest folio of the 15th century. All that extra weight was not real finish, it was

only trade finish, and was done in order that the books might sell. There was as much hope of doing something in the way of producing good-looking and even beautiful books, as of getting any betterment in any kind of decoration whatever; and after all it need not cost more to print books from beautiful stamps rather than ugly ones. He had the highest possible hopes, if artists would only be true to themselves.

NINTH ORDINARY MEETING.

Wednesday, February 10, 1892; The Right Hon. Sir LYON PLAYFAIR, K.C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Ashburner, Lionel Robert, C.S.I., 9A, Gloucester-place, Portman-square, W.
Hervey, Hubert J. A., 12, Lowndes-street, S.W.
Hughes, John, Chester; and 16, Great George-street, S.W.
Jex, Edward, 27, St. Mary-at-Hill, E.C.; and the Dukeries, Springfield, Chelmsford, Essex.
Rickmann, Adolph, 59, Knightrider-street, E.C.
Sessions, Frederick, Russell-house, Gloucester.
Simpson, Edward Henry, 100, St. Martin's-lane, W.C.
Smith, W. A., Houghton-house, Arundel.

The following candidates were balloted for and duly elected members of the Society:—

Ames, Thomas R. J., 49, Maury-road, Stoke Newington, N.
Browne, Rev. Canon George Forrest, B.D., 54, Bateman-street, Cambridge, and 2, Amen-court, E.C.
Bryden, W. R., 1, George-street, Buxton.
Buchanan, John Young, M.A., F.R.S., 10, Moray-place, Edinburgh.
Chubb, John C., 128, Queen Victoria-street, E.C.
Clarke, Somers, F.S.A., 15, Dean's-yard, Westminster, S.W.
Constable, Archibald, 14, Parliament-street, S.W.
Corder, William, Feeringbury, Westbourne-road, Edgbaston, Birmingham.
FitzGerald, Prof. Maurice Frederick, B.A., Queen's College, Belfast.
Gaymer, John, North Walsham, Norfolk, and John-street Adelphi, W.C.
Gujpatee, Rajah Goday Naraen, Rao, Vizagapatam, India.
Haden, William Nelson, Homefield, Trowbridge.
Halsey, W. S., 213, Cromwell-mansions, S.W.
Hawkins, Herbert Spong, London, Brighton, and South Coast Railway, London-bridge, S.E.
Hughes, John Griffith, Atlantic Engine Works, Bootle.
Kirkaldy, James, 68, East India-road, E.
Ledward, Thomas, 9, Pendrell-road, Brockley, S.E.
Macan, H., M.A., Imperial-buildings, Ludgate-circus, E.C.
Mackenzie, Captain R. J. H. L., R.E., Karachi, India.
Miller, Adam, 11, Queen Victoria-street, E.C.
Oppert, Dr. Gustav, Presidency College, Madras.
Pascoe, James Rogers, Pyrmont, Woodford-green, Essex.
Penfold, Harold, 14, Priory-road, Bedford-park, Chiswick.
Rose, Tom Kirke, 9, Royal Mint, E.
Rowell, Herbert, Hebburn-hall, Hebburn-on-Tyne.
Sibson, Alfred Edward, 2, St. John's-villas, Palmerston-road, Buckhurst-hill, Essex.
Thorp, Walter, B.Sc., The Limes, Henry-road, New Barnet.
Travancore, His Highness Sir Rama Varma, Maharajah of, G.C.S.I., The Palace, Trevandrum, Travancore, India.
Watney, Walter D., 33, Poultry, E.C.
Wilson, Captain Robert Charles Dighton, 21, Chesham-street, Belgrave-square, S.W.
Wilson, Walter H., Queen's-road, Belfast.

The paper read was—

BURNING OILS FOR LIGHTHOUSES AND LIGHTSHIPS.

By E. PRICE EDWARDS.

This paper is not intended to re-open the controversy in respect of the relative merits of oil, gas, and electricity as lighthouse illuminants. My purpose is to give a simple account of the use of various kinds of oil for the illumination of lighthouses and lightships in this and neighbouring countries; to show what has been done in the past and what is being done at the present time.

It should also be understood that I do not propose to enter into minute technical details regarding the chemical composition of the oils, but shall present to you facts of a more or less general but essentially practical character, which have come under my observation while carrying out my duties as an official of the Trinity-house Corporation.

The importance of the subject as affecting the safety of life and property at sea, and facilitating navigation in the dangerous waters near to our shores, will probably be regarded as sufficient justification for its presentment before this Society.

Up to the middle of the last century, and in some cases up to the early part of the present century, British and other sea lights were

simply bonfires fed with wood or coals, or bales of pitch and oakum, burned in open fixed grates, or swinging iron baskets, known as "chauffers." Such lights as guides or warnings to mariners were frequently of the least service when most needed; at the best they were uncertain and insufficient, their smoky, ill-burning flames or red-hot fuel being visible at very short distances at sea. It is said, however, to have been an advantage possessed by these bonfires that their light was, at times, reflected in the sky, whereby mariners were enabled to fix approximately the position of the light-tower itself. The employment of these fiery materials seems to have lessened when candles of tallow came into use. One trustworthy record of this we find in Smeaton's work on the Eddystone Lighthouse, wherein he says that the light was maintained with twenty-four candles, "whereof five made two pounds." He further tells us that it was very necessary to keep the lantern cool, complaint having been made of "it being so hot, especially in the summer, as to give much trouble by the running of the candles." It will be understood that an important function in connection with the use of tallow candles was the snuffing of them, and the old clock in the Eddystone tower was set to strike once every half-hour "to warn the keepers when to snuff the candles."

It is not easy to find any exact records of what was the actual practice in respect of the majority of the lighthouses in those comparatively dark ages, but stated in general terms it may be accepted that wood, pitch bales, coals, and candles, were the main illuminants for lighthouses up to the middle of the last century, and that they were all miserably inefficient for the purpose.

As an illuminating agent for domestic purposes, oils of various kinds have been, as you must all be well aware, employed from time immemorial, and it is more than probable that, for small harbour and fishermen's lights, oil of some kind was used, but the appliances for burning oil were then so imperfect that a light so produced was regarded as quite inferior to a coal fire.

Not until the invention of the Argand oil burner, about 1784, was anything like a real advance made in the use of oil for sea lights. Most of the difficulties which had previously prevented oil from being used for that purpose were overcome by the splendid invention of M. Argand, and thenceforward oil quickly displaced all other illuminating agents for lighthouses. It is now more than 100 years ago since that distinguished Frenchman perfected his burner, and to this day the large majority of oil-burning lamps are constructed on the principle then discovered and realised by him.

Perhaps I may be here permitted to refer briefly to the manner in which oil is consumed and light produced while a lamp is in operation. Of course, the process is quite familiar to many of my hearers; but, as it will be a convenience to me to state it here, and it may possibly be useful information to some of you, I will ask the indulgence of those who know all about it. In the first place, it should be realised that, when oil of any kind is consumed, by burning in a lamp or elsewhere, and flame is the result, the liquid itself is not inflamed. We talk freely enough of the burning of oil, but what really burns is the vapour or gas of the oil. In lighting a lamp, in the first instance, the flame of a taper or match is applied to a portion of the oil-sodden wick, and the heat of this flame converts the oil in that part of the wick into vapour or gas, and the same flame ignites the oil vapour. The burning vapour will then continue the manufacture of more vapour, as additional oil is supplied to the wick, and thus the oil will be consumed by evaporation, until there is no more oil in the lamp to be drawn up the wick for conversion into oil vapour. One other point to be borne in mind is that, in the act of burning, the vapour combines chemically with the oxygen of the atmosphere; and, as oxygen is the principal supporter of combustion, it follows that, the more effectually air containing oxygen can be supplied to the flame, the more perfect and vigorous will be the burning of the vapour.

It was the recognition of this principle which enabled Argand to accomplish his great work, and to produce an oil burner associated with a glass chimney, by means of which the flame of a cylindrical wick was fed with air internally and externally, whereby vastly improved combustion of the oil vapour was effected, the smoky and snuffy solid wicks then used for oil lights were banished and the maintenance of a clear steady flame rendered possible. Briefly stated, the great invention consisted of the introduction of a hollow cylindrical instead of a solid wick, working on a hollow metal cylinder open at the bottom and at the top, whereby air was admitted into the centre of the burning ring at the top to the wick. A glass cylinder outside the wick drew up a circular current of air, and

caused it to impinge upon the outside surface of the flame, and also prevented irregular draughts and puffs of air from striking the flame. With this burner was associated a cistern, so placed that the oil should flow by gravitation down the supply pipe to the burner, and, immersing the wick, would be maintained in the burner tube at a constant level very near to the top of the burner, the portion of wick above this level being fed with oil by capillary action, the oil creeping up the wick to the burning point. Of the further extension of the Argand principle I shall speak presently. I refer now to M. Argand's great invention, because it marks the period of the real advent of oil as an illuminant for lighthouses.

At the period indicated fish oils of several kinds were employed for various purposes, including illumination, but the lighthouse authorities seem, by common consent, to have adopted spermaceti oil, obtained from the South Sea whale, as the most suitable for their purposes, and at the close of the last century this was, in the northern latitudes, in pretty general use. From about 1790, sperm oil was burned with good results in the Argand lamps used for lighthouses in England, Scotland and Ireland, the United States, France, and other European countries up to 1832. In that year France changed her oil, but Great Britain and Ireland held on to the sperm for another twelve years, the authorities being well satisfied with its suitability and efficiency, and being apparently unwilling to make a change which might prove of doubtful advantage. At this time the market price of sperm oil ranged from 5s. to 8s. per gallon, and there was no lack of the commodity. But as time went on, prices showed a continued upward tendency; ominous rumours were current that the supply being dependent upon the success of the whaling industry would become restricted as the demand increased. Furthermore, colza or rape-seed oil was entering into competition with it at about half the price, and in 1845, after careful experiments, the Trinity-house Corporation acted upon the recommendation of a Select Committee of the House of Parliament, and determined to adopt this oil for their lighthouses and lightships in lieu of sperm, on account chiefly of the much lower price of the former.

This is the oil which had been used in French lighthouses since 1832, with good effect. The oil is obtained by expression from the seeds of the rape plant, a small wild cabbage (*Brassica oleracea*) grown to a considerable extent in France and Belgium. Its price per gallon was then 3s. 6d. as against 7s. for sperm, and therefore its adoption effected a large saving. When its employment was under consideration, some trials as to its value as a lighthouse illuminant showed that the lamps then in use with sperm were not suited for burning this vegetable oil; but, by the efforts of Mr. Wilkins, of London, Mr. George Herbert, of the Trinity-house, and Mr. Stevenson, in Scotland, who each designed a lamp suitable for burning rape-seed oil, this difficulty was overcame. It was also found that with suitable burners the light-yielding powers of the fish and vegetable oils were about equal, while there was no material difference as regards consumption. Thenceforward all classes of burners used in lighthouses and on board lightships in the United Kingdom were gradually adapted for the use of the new oil. Its great safety, its effective illuminating power, and its economy, as compared with sperm oil, combined to cause it to be regarded as a most desirable illuminant; and, for many years it has been in use, latterly, however, in diminishing quantities. In connection with the contracts made for the supply of this oil for lighthouse purposes, the greatest care has always been exercised to ensure the oil so supplied being of the purest and best quality. The samples submitted with the annual tenders, and the deliveries subsequently made by the contractor, were subjected to severe tests, comprising chemical examination for free acids or adulterating elements, test of capacity to withstand congelation at 25° F., 16 hours' continuous burning, during which period the wick must not be trimmed, and measurements of the illuminating power taken every few hours, and, at the end, the wick carefully examined, to see if any incrustation had formed which would injuriously affect the maintenance of the light. Each cask of oil delivered is sampled, and carefully tested, as above indicated, to ensure its being of a quality equal to that submitted with the tender of the firm holding the contract. Any impurity in colza oil is tolerably certain to make itself evident in the burning: the foreign substance will most probably carbonise in the wick at the burning point, and will hinder the proper quantity of oil being evaporated, thus impairing the effectiveness of the flame, and, if prolonged, causing it to sink, so as to be of no value as a light. It is obvious that the strictest tests are a necessity. The oil

for the Trinity-house service, when approved, is started into large iron cisterns, each capable of holding 9,000 gallons, and after being allowed to settle down for a month or two, a process which improves all animal and vegetable oils, is drawn off into iron drums (five gallons each) tinned inside, and despatched by the lighthouse tender to the lighthouse or lightships.

In 1852, a new Lighthouse Board, for the United States of America was constituted, and one of the first questions they dealt with was that relating to the substitution of another and cheaper oil in place of the sperm oil there in use. Following the lead of France and England they inquired as to the possibility of employing rape-seed oil. The difficulty experienced in their investigation was that this oil would have to be imported from Europe, as no available means existed for its home production. An endeavour was made by the Board to stimulate the cultivation of the rape plant and the manufacture of the oil in America, but without success. While this effort was in progress, Professor Henry made a number of experiments with various oils, but more particularly with lard oil, and arrived at the conclusion that it was possible to burn this oil satisfactorily in lighthouse lamps. Moreover it could with facility be manufactured in America, and supplied at a price considerably less than would have had to be paid for colza. Consequently, about 1861 lard oil became the illuminant in all the lighthouses of the United States, a special lamp for burning it having been designed by Mr. Joseph Funck, the foreman of the lamp shop of the United States Lighthouse Board. The principle of the lamp was that of the Argand, but its speciality was that the reservoir for the oil was so placed that the heat of the flame passed through its centre, it being a necessity in order to get the best effects from this oil that it be kept at a high temperature, it having a marked tendency to congeal at temperatures below the normal.

The possibility of using petroleum had been many times mooted in the United States, but no safe methods of burning it at this date seem to have been available. Sundry accidents had happened in its manipulation, and petroleum had gained the reputation of being a dangerous explosive liquid which should only be handled with the greatest amount of caution. It was not, therefore, thought desirable to depart from using the safe lard oil. As late as 1872 a Committee from the Trinity-house of London visited America, and found lard oil in general use in the lighthouses of the country, and it continued to be so employed up to 1879. The average price paid for it was 1 dollar 10 cents per gallon, as against 1 dollar 64 cents for sperm.

Among other vegetable oils which have been used for lighthouses may be mentioned olive and cocoa-nut oils. The former has yielded very satisfactory results in a burning test made at the Trinity-house about six years ago; the illuminating power obtained being quite equal to that obtained from the best colza. The oil, however, was quite solid at 25° Fahr. It was, in former days, used in some Irish lighthouses, and many of the Mediterranean lights were also illuminated by its agency; but its cost, in 1867, was about 6s. per gallon, as against 3s. for colza; therefore it could have no chance in the competition with colza, apart from its liability to congeal. It is still used in some of the small Mediterranean and Asiatic lights.

Cocoa-nut oil has been, and still is, employed to a considerable extent for lighthouses in India and Ceylon, but it is now being displaced by mineral oils. A sample tried at Trinity-house showed that, when kept in a liquid state, it could be burned, and yielded fairly satisfactory illuminating results; but it was necessary to keep a lamp burning under the oil cistern to keep it fluid. It is not at all adapted for illuminating purposes in these latitudes, as it becomes solid at ordinary temperatures. Moreover, its price here would not have allowed it to compete with colza.

The progress made in the further development of lighthouse burners during the period when sperm and colza were the illuminants is worthy of notice, as the additional knowledge gained had doubtless a great deal to do with the further utilisation of oil for lighthouses. The Argand principle had to be adapted to new conditions when the lens system of Fresnel came into use. Previously the great beacon lights on our coasts had been produced by a number of single-wicked Argand burners, each placed in a reflector. If the light was meant to be fixed, *i.e.*, continuously shining, showing with equal effect all over the arc to be illuminated, the lamps and reflectors would be suitably arranged around a cylindrical framework, so that their rays should proceed continuously in the direction required; but if the light were to be revolving or flashing, a certain number of the lamps and reflectors would be fixed on each face of a polygonal framework,

and the whole framework set in rotation, whereby each group of lamps on a face would send out a beam of their combined rays, and each beam would successively travel over the seaward arc requiring to be illuminated. This is, as you doubtless are aware, known as the catoptric system of illumination. It is in operation at only a very few lighthouses now, and these will probably be changed to the more perfect or lens system in due course. On board lightships, however, the Argand lamps and reflectors have to be retained in consequence of the movements of the vessel rendering lenticular adjustment very difficult and costly. With the dioptric system one large burner only is used, placed in the centre of the lighthouse lantern and surrounded by a structure of glass lenses and prisms, the use of which is no doubt familiar to all. When Fresnel was completing the application of his lens system, the necessity arose of providing a larger and more powerful burner than the single-wicked Argand, and, in conjunction with his friend, M. Arago, he produced an enlargement of the Argand burner, having four concentric wicks. With all the four wicks alight the flame, of this burner was about 4 in. high and about 3½ in diameter. Each wick was independent of the others, air spaces separating the circular wick cases, and the oil was supplied to the wicks by hydrostatic or mechanical pressure. In such burners both sperm and colza oils were freely used, and up to the year 1872 no greater number of wicks than four were employed in any burner, and colza oil was in general use in all British lighthouses.

Sir Lyon Playfair, who has shown his appreciation of the importance of my subject and honoured me, by presiding this evening, will well remember calling the attention of Mr. James Young, in the year 1848, to the oozing out of some petroleum above a coal-working at Alfreton in Derbyshire, and suggesting to him that it might possibly afford a profitable subject for investigation. From that suggestion most important and valuable results have emanated. That particular supply of petroleum quickly gave out, but not until Mr. Young had, after careful observation, formed a theory as to how it had been formed. This theory he subjected to experiment; he followed what he believed to be the natural process by which the petroleum had been formed, and by the slow distillation of coal he produced a liquid (now known as crude oil) somewhat similar to that which had oozed out at Alfreton. The yield of liquid from a ton of coal was about fifty or sixty gallons; but subsequently Dr. Young's attention was drawn to the Torbanehill or Boghead bituminous mineral, which was found to contain a much larger percentage of carbon than the coals he had previously distilled. Subjecting this new raw material to his process, he succeeded in extracting from it as much as 120 gallons of crude oil per ton. There being extensive fields of bituminous shale in Scotland, the extraction of paraffin oil rapidly grew into an important industry.

Briefly stated, the process is to place the shale in retorts to which a gradually increasing heat is applied. All the volatile constituents of the shale are thus vaporised, and the vapours so formed conducted off by pipes to be condensed. The whole of the resultant condensed liquid is crude oil, a dark-green viscous fluid with a specific gravity of ·870 to ·885. A considerable quantity of the vapour remains uncondensed, and is led off to be utilised for heating purposes. The next process is the distillation of the crude oil in order to obtain from it the various products required. This is also a gradual operation, and is continued until the oil is distilled to dryness. The first application of heat to the still releases the most volatile elements; as the heat is increased, the heavier portions of the crude oil are vaporised. It is important to note this operation, showing the quality of the different paraffin burning oils as extracted, The early distillate is given up to the production of gasoline and naphtha, and is cut off when the condensed vapour in a liquid state has a specific gravity of ·770. These products are highly inflammable, that is to say, they will vaporise at comparatively low temperatures. The next section of the distillate is devoted to burning oils, the specific gravity of which ranges from ·770 to ·850. It is this section with which we are chiefly concerned. The further extension of the distillation yields lubricating oils containing solid paraffin. The burning oil is subjected to chemical treatment for purifying, and a process of fractional distillation to enable the oils to be separated into different qualities to suit the markets. For the general public the lighter oils are appropriated, having a specific gravity ranging from ·795 to ·810, and none of these can be vaporised at temperatures below 90° F. (Abel test). The oil for lighthouses is specially selected, and has a specific gravity of from ·810 to ·820 and cannot be vaporised

until subjected to a heat of 145° F. Let me here observe that the temperature at which mineral oil can be vaporised is the test of the safety of any such oil, and is known as its flashing point. The vapour evolved is inflammable in the open, and explosive if confined. I do not mean that any spontaneous inflaming or explosion will take place, but simply that the application of flame to the vapour will ignite it. Specific gravity in itself is not a test to be depended upon. The lighthouse oil, it may be observed, does not give out dangerous vapour until it is heated to a temperature above 145° F.

As I before remarked, the industry of making paraffin-burning oils is a large one in Scotland, the whole having grown out of the enterprise and skill of Mr. James Young, encouraged and assisted by such eminent scientists as our chairman of this evening.

While Dr. Young was pursuing his investigation with the Boghead mineral, the French lighthouse authorities were making trial of oil extracted by distillation from the bituminous schists of the Department of Allier, and found it possible to burn the oil in a single-wicked lamp invented by a M. Maris. The result of the trials was that a few small harbour lights were illuminated with this oil. Some accidents occurred which had the effect of alarming the authorities, and of causing its use to be proceeded with very cautiously, and it was for several years confined to single-wicked lamps.

In 1868 Captain Doty, who had given some attention to the subject of mineral oil burning, came upon the scene, and put himself in communication with various lighthouse authorities. On his introduction by the late Emperor, Napoleon III., to the French authority, he submitted burners with three and four concentric wicks, which he alleged were suitable for burning the new mineral oil, and in 1869 at the La Canche lighthouses a trial of the Doty lamp with schist oil, as then supplied, was made in comparison with a Colza lamp. But although good results as regards the mineral oil burner followed this trial, the further application of this illuminant for lighthouse purposes was not proceeded with owing to the fear of accident by explosion with the schist oils then in the market, the uneasiness being increased by a report made at the time by the chairman of the United States Lighthouse Board, that although mineral oil was abundant in their country, it was not thought advisable to use it in lighthouses there on account of its inflammability. It is possible that the schist oil was either inherently of inferior quality to the Scotch paraffin or was badly made. But however that may be, Young's Paraffin Light and Mineral Oil Company, which was at that time in existence, submitted to the French authorities the paraffin oil manufactured by them, and as a result of the trial made it was found that the Scotch oil was less inflammable and dangerous, and a better illuminant than the schist oil then in use in single-wicked lamps. They further made a careful examination of the relative merits of this oil as compared with all the mineral oils of French origin, with the result that the superiority of the Scotch paraffin was conclusively proved, and in January, 1870, a three years' contract was made with Young's company to supply the oil required. In 1873 we find that the Commission des Phares gave the order for the substitution of mineral oil for colza in all the French lighthouses, on the grounds that its cost was one-half that of colza; that with proper tests on receipt of the oil its safety could be ensured; that the light yielded by it was superior to that from colza, and the lamps with mineral were more easily managed than those burning colza. The burners used were those of Doty and Lepaute, the former gentleman receiving, in recognition of his efforts, a grant from the French Government, in addition to the price of any burners supplied by him.

In this country, the question of using mineral oil in lighthouses had been under consideration before 1868; indeed, both the English and Scotch lighthouse authorities had for some time been inquiring and working at the subject. It is right to say that the intervention of Captain Doty in the investigation and competition helped the matter forward considerably. At first, he submitted to the Trinity Board only a single-wicked Argand burner, adapted for burning mineral oil; but suggestions were made to him at the time as to the mode in which four consecutive wicks were used in some lighthouse oil burners. Upon this hint Captain Doty appears to have acted promptly, for he shortly afterwards produced three and four-wick burners adapted to burn mineral oil, which burners he subsequently, as we have seen, introduced to the French authorities with some success. The Trinity-house engineer, and the engineer to the Commissioners of Northern Lights were at the time experimenting, with the object of adapting the then existing lighthouse burners for the combustion of mineral oil. The Trinity-house proceeded

with the investigations and trials, and ultimately the Douglass mineral oil burner was perfected. The Northern Commissioners accepted Captain Doty's burner as furnishing a solution to their inquiry. The deliberate proceedings taken in connection with the introduction of paraffin as a lighthouse illuminant, are justified by the important considerations which must be taken into account, before a safe and well-tried oil could be displaced in favour of an oil having, to say the least of it, a doubtful reputation.

Elaborate and careful trials were conducted by Dr. Stevenson Macadam, in Scotland, and Professor Tyndall and Mr. Valentin, in England, ably assisted by the engineers to the respective Lighthouse Boards; and, in 1870, Dr. Macadam reported that "paraffin oil consumed in Doty's lamps, alike from readiness in trimming and lighting up, from steadiness of flame, and from high photogenic power, possesses decided advantages over colza oil for lighthouse illumination; whilst the quality of the best mineral oil now to be obtained in the market renders the employment of paraffin oil practically safe." In 1871, Dr. Tyndall supported Mr. Valentin in a strong recommendation that the use of paraffin oil be extended, stating that "the consensus of evidence leaves no doubt upon the mind that, as regards cost and illuminating power, the paraffin light really possesses the advantages claimed for it;" while, from the practical point of view, Messrs. Stevenson and Mr. Douglass reported most favourably upon the new illuminant, and upon the safety and effectiveness with which it could be used in lighthouses. By the year 1873 all doubt had disappeared, and paraffin was rapidly displacing colza oil in the majority of lighthouses in the United Kingdom.

While European authorities were adopting paraffin as a lighthouse illuminant, the United States authorities again resolved to give consideration to the matter. They had become better acquainted with and possibly less timorous of the petroleum which was spouting up so freely in their country. The action of Mr. James Young, and the development of the paraffin industry, opened their eyes to the possibilities of utilising the rock oil of their country. It is a curious fact that before the Americans knew the value of their petroleum, the process of distilling shale and making paraffin, under Young's Patent, was carried on in America. When they realised what their great possessions were, there was, you may depend upon it, a "boom in oil."

In 1874, the Lighthouse Board investigated and experimented: they tried a great number of mineral oils, and in the end resolved to have petroleum of a certain quality. It took several years to change their burners, but ultimately, I believe in 1879, all were adapted, and lard oil became a thing of the past so far as lighthouse illumination is concerned.

In Canada the petroleum obtained in the Dominion had been in use for lighthouse lamps before 1870. In those days Canada was less advanced than she now is, and her coast lights were of a somewhat primitive character, although probably sufficiently effective for the purposes required. The lighthouses were simple structures, built of wood from the forest close by; the burners of simple construction in reflectors; the oil from the nearest source. Under the energetic direction of Mr. William Smith, the Deputy Minister of Marine, many of the lights were subsequently improved by the adoption of the large four-wicked concentric burners, but it was then found that the Canadian petroleum was not suitable for these large burners, as under the great heat developed the wicks were carbonised and capillary action checked. Now, I am informed, the oil for these burners is supplied from New York.

The use of mineral oil for lighthouses has not extended very rapidly in other British colonies. To this day colza is largely employed; but as prejudices against the use of mineral oils die out, and the freight for such oils (unreasonably kept up as regards lighthouse oils on the ground of danger) is lowered, and also as the petroleum found in various parts of the world is brought into practical account, we may expect mineral oil to displace all others.

For those to whom the terms paraffin and petroleum are confusing, let me say that paraffin oil is extracted from bituminous shale, as I have before described, while petroleum exists in the earth as a crude oil, and is drawn therefrom in a liquid state. Speaking generally, it may be said that the crude oil resulting from the destructive distillation of shale is somewhat similar in character to the crude petroleum oil. There are, of course, many differences in detail among all mineral oils, but taking them as crude oils from which burning oils have to be obtained, we may consider the question of how a safe oil for lighthouse purposes can be and is produced. These crude oils are subjected to somewhat similar processes for their refinement. It has been stated that the section of the distillate

devoted to burning oils consists of a mixture of hydrocarbons of varying volatility; the early portion of the distillate is therefore more volatile than the last portion, the former having required less heat to vaporise it than the latter. Suppose then the section of burning oils has been obtained by the application of heat from 300° F. to 600° F., this section may be cut up into further divisions, the first part of which would consist of light oils, with a specific gravity of from ·790° to ·810 and a flashing point, as regards paraffin, of from 90° F. to 105° F., and as regards ordinary petroleum, from 73° to 90° F. Such light oils as these are mostly used by the general public for ordinary burning purposes, and are retailed in this and other countries.

In refining crude petroleum a very large fraction of the burning oil section consists of this light oil, and the refiners are naturally desirous of disposing profitably of this oil, which might, if not available for illuminating purposes, remain on their hands as more or less a waste product. The trade in American petroleum is now a large and important one, but was young and undeveloped when the Petroleum Acts of 1862, 1868, 1871, and 1879 were passed, and the framers of those Acts may have thought it desirable to so far encourage this trade by lessening to a minimum the restrictions upon those light oils being brought into and freely distributed throughout the country. In these Acts the oil indicated as dangerous, and as requiring to be specially restricted as regards its transport and storage in this country, is that which gives off inflammable vapour at a temperature below 73° F. (Abel test), while all oils flashing at or above that temperature are not regarded as dangerous by Act of Parliament. The consequence is, this country is practically flooded with American oil, of which a very large proportion gives off inflammable vapours at temperatures between 73° and 80° F., which oils, in my humble judgment, are essentially dangerous, no matter in what improved or safety lamps they may be used. Temperatures of 73° to 80° F. are frequently experienced in summer weather, and then these oils evolve their vapour. Again, in a lamp burning with this light oil, the conduction of heat from the burning point to the oil receptacle may quite possibly raise the metal, or other material enclosing the oil, to a temperature above 73°; and this heat, communicated to the oil, would cause it to vaporise, and the space above the surface of the oil, if ignited there, would cause an explosion, and if the lamp were upset, the oil would most probably immediately inflame, on coming into contact with the burning wick. From the point of view of danger, I venture to think too much reliance is placed upon special safety lamps, and too little consideration is given to the inherently dangerous nature of the oil used. I fear many, if not the majority, of the accidents which have happened with mineral oil lamps have been due to the fact that large quantities of low-flashing oil are sent unrestricted into the markets of this country, and distributed for sale to all the retail shops in the United Kingdom. Oils of the character here referred to would never be used in lighthouse or lightships, on account of the serious risk which would be incurred of accidental conflagration.

In the majority of cases of refining petroleum no such section as above referred to is cut off, the whole of the fractions of burning oils, from light to heavy, being mixed together. But, in the case of paraffin manufacture, after the light oils are cut off, then what is known as lighthouse oil—of specific gravity ·810 to ·820 and minimum flashing point 145° F.—is cut off. This is the kind of mineral oil which has been in use by the British lighthouse authorities for the past 18 years; and the several firms who annually tender for the supply of this oil are fully aware of the requirements. It does not appear to have been considered by the American petroleum firms worth their while to compete with the Scotch companies for this special business, although tenders are invariably invited by public advertisement. It does not seem that there should be any very great difficulty in supplying American petroleum to meet the requirements of the lighthouse Boards, but they probably are not disposed to cut out of their distillates the limited fractions of the burning oils section which would be necessary. Probably the same reasons apply in some measure to the refiners of Russian oil. Several samples have been sent for testing, but the flashing point in each case was below the specified limit, and in the test lamps at the Trinity-house the flame was inclined to be a little smoky and fell off after seven hours' burning. But it may be hoped that the Baku managers will send another sample taken from a narrower cut out of the best portion of their burning oil distillate.

The paraffin referred to is quite safe to use in lighthouses, and with burners of six and eight wicks. In these large burners the oil in the wick cases is maintained by regulated pressure

at a constant level about three inches below the burner tips, where it is found that the heat of 120° F. is not reached. Just above the position where it is necessary to maintain the constant level, the wick-cases are drilled with small holes, so as to enable the oil to overflow if it should rise above the proper level. As a matter of fact, the pressure causes the oil to have a constant tendency to rise, thus a constant overflow is established, whereby cool oil is continually supplied to the wicks, and prevents the metal at that point from becoming unduly heated. I took the temperature of the overflow oil of a ten-wick burner last week, and found it was 108° F. The lamp was being worked with only a little oil, and the overflow oil was flowing back to the reservoir, the temperature of oil in the reservoir being 94° F. At neither of these temperatures could inflammable vapour be given off, and therefore the oil was as safe as it could be. Oil is quite safe until it begins to evolve vapour. Prevent vapour forming in your lamp, except at the burning point, and you have nothing to fear. This you can achieve by using oil which will not vaporise until it reaches a temperature of say, 120° F. During the eighteen years paraffin has been in use in English lighthouses only one serious accident has happened, and that was due to mismanagement on the part of a keeper.

For lighthouses on isolated rocks at sea, and on board lightships, even the paraffin with flashing point of 145° has not been regarded as suitable. The consequences of an accidental firing of the oil in a rock lighthouse might be very disastrous, and the Trinity-house Corporation with their engineer have not been willing to encourage the possibility of this risk. On board a lightship, where there is a number of swinging lamps in the lantern at the masthead, which in bad weather, as the vessel rolls and labours in the sea, are subject to violent oscillations and jerks whereby the oil is frequently spilled, and in very severe weather sometimes thrown about the lantern, it has not been considered desirable to use the Scotch paraffin; although in French lightships an oil of that character has been burned for some years.

But in the year 1885 an oil was brought to the notice of the Trinity-house, with a flashing point of 250° F. (Abel test). This was an American petroleum, and probably consisted of a portion cut out of the burning oil section rather late in the process of distillation of the crude oil. The promise of this oil was so favourable that careful trials were made with it, and excellent results as regards illuminating power were obtained from it. Its capillarity was a little less than the paraffin in use, and to burn it in the large burners necessitated a raising of the constant level, and a little different adjustment in the burners. Sir James Douglass quickly recognised the value of this oil, and after a practical trial had been made of it in the lamps on board the Goodwin Light Vessel, it was resolved to proceed further. Colza was still the illuminant at rock lighthouses and on board lightships; this new oil could be supplied at about one-fourth the price paid for colza, could be burned more easily in the adjusted lamps, was liked by the lamp-trimmers as being cleaner and more easily managed, and could not become dangerous until heated to 250° Fahr. With all these recommendations, it is not surprising that the Trinity-house, with the concurrence of the Board of Trade, arranged that this oil should be used at all lighthouse and lightship stations where colza was then in use.

On further inquiry, it was found that if there were a demand for such oil, there would soon be a supply to meet it. The Thompson and Bedford Company, of New York, were the first to put the oil into the market, but other companies have proved since that no firm has a monopoly of the supply of this oil. The Broxburn Oil Company sell paraffin oil of similar character, and other Scotch companies are prepared to supply it if required. The Trinity-house at once proceeded to adapt all the remaining colza burners for burning this new oil, and have progressed so much that, instead of taking a contract for 300 tons of colza, as used to be the case, the quantity to be taken this year will probably not exceed 10,000 gallons, if any is taken at all. Such mineral oil as this is, indeed, safe, and ought to commend itself to the public at large. It has been stated that oil of this character develops more heat in burning than the low test oil. If this were really the case, there would still be such a large margin of safety in the oil that it could not be of material consequence. But, from trials made by myself and others, it does not appear that there is a greater development of heat with the high-test oil as compared with low flashing oils.

I made a trial, a few days ago, of five mineral oils burning in domestic lamps of similar construction, and took the temperature of the oil in the reservoir of each after five hours' burn-

ing, the bulb of the thermometer being kept in the oil the whole period. The results are shown in this Table :—

Oil used.	Flashing point. (Abel Test.)	Temperature of oil after 5 hrs. burning.
	Deg.	Deg.
1. High-Test Petroleum ..	248	86
2. Paraffin Lighthouse	154	86
3. Water-white Petroleum..	114	87
4. Russian Petroleum......	86	85
5. Standard-white Petroleum	76	88

I then applied a flame to the filling hole of each successively, and from the first three there was no indication of vapour, although the flame was put completely into the reservoir. On applying the flame to the fourth, there was a slight indication of disturbance; but on applying it to the fifth, an explosion immediately took place, a tongue of flame shooting up from the filling hole about a foot long, and the flame of the burner was forced up the chimney by the pressure of the exploding gas in the oil in the reservoir. This proves that, with No. 5 oil, having a flashing point of 76° F., the oil in the reservoir was heated to 88°, and a large quantity of inflammable vapour had formed, which was stored in the reservoir, and which inflamed violently on applying a lighted taper.

This is a result which deserves the careful consideration of all users of mineral oils. Suppose, while this storage of oil vapour exists in the lamp, the oil in the reservoir requires replenishing. The filling hole will perhaps be opened, and the inflammable vapour liberated; it might then ascend to the flame through the air-holes, or a lighted taper or match brought near, to show much oil to be poured in; in either case the consequences might be very serious.

Other experiments, carried out in greater detail, have been made in this direction, from which similar results were obtained. The three oils which give off no vapour show that safe mineral illuminants are obtainable either of petroleum or paraffin, and that the lighthouse authorities are enabled to use it without risk and without difficulty. The introduction of this oil has enabled Sir James Douglass to perfect his burners of all classes; and the Trinity Board have arranged that the modified burners which have been displacing the colza lamps ashore and afloat, shall be in every case more powerful; and the result is that, while the lights shown for the mariner's benefit have been vastly improved, the cost of producing these lights has been considerably decreased as compared with the colza lights; while the element of safety has been preserved by the adoption of oils which may be consumed in the largest burners without risk.

It may be interesting to note that by the change to mineral oil the illuminants for sea lights have successively been obtained from animal, vegetable, and mineral sources, and that the cost per gallon has descended in the three stages from about 6s. to 3s., and to 1s. 4d. At the present time paraffin of the quality required and high test petroleum can be obtained at about 6d. per gallon. With this great decrease in cost, the question of the relative consumption of colza and mineral oil is practically unimportant, but, as a matter of fact, it is found that in similar burners there is rather less mineral oil consumed to maintain a maximum flame than with colza. The increased power of lights necessarily involves an increased consumption of oil; but the cheapness of the oil makes the additional expenditure a matter of small account.

It may be freely admitted that those who have striven with so much zeal and success to make gas lighting available for lighthouses, have by their efforts greatly stimulated the development of oil burners; and this development has been favoured, in a marked degree, by the introduction of the safe mineral oils to which I have referred. It was thought a great advance when the four-wicked burner was enlarged by two additional concentric wicks; but, since that was accomplished, burners of 8 and 10 wicks have been perfected by Sir James Douglass.

Eight-wick burners, consuming paraffin or high-test petroleum, are now installed at the lighthouses of Coquet, Whitby, and Bishop Rock, Scilly; and ten-wick burners are established at the lighthouses on the Casquets in the Channel Islands, and Round Island, Scilly.

In clear weather, seven of the inner wicks of the 10-ring burner and five of the 8-ring burner are suppressed, the full power of each being employed only when the atmosphere is thickened by fog, mist, or snow. The candle-powers of the unassisted flames of each burner with mineral oil are as follows :—

Trinity-house	Douglass	single-wicked	burner		20	candles
,,	,,	two	,,	,,	60	,,
,,	,,	three	,,	,,	180	,,
,,	,,	four	,,	,,	350	,,
,,	,,	six	,,	,,	835	,,
,,	,,	eight	,,	,,	1,500	,,
,,	,,	ten	,,	,,	2,215	,,

The old four-wicked Fresnel burner, with colza oil, gave 230 candles.

In connection with the oil burners, I must not omit to refer to the very important question of the cotton wicks employed as a vehicle for carrying the oil up to the burning point. With sperm and colza oils a rather hard closely woven wick was in use, and as nearly the whole of the wick was steeped in oil, only about 3-8ths of an inch being above the constant level, its texture and suitability for promoting capillary action were not of great consequence. But when paraffin was introduced, the nature of the oil rendered it necessary to alter the mode of burning. Being so much more volatile than the animal and vegetable oils, it would have been dangerons to bring the constant level of the paraffin very near to the flame, and the oil would not have been consumed satisfactorily. It was, however, fortunately discovered that this oil had great capillarity or creeping power (a peculiarity which is sufficient to explain what has often been called the sweating of metal and glass receptacles of this oil), and that if the wick were immersed up to a point two or three inches below the top the oil would rise in it by capillary action up to the burning point. To facilitate this action it was necessary to displace the old closely woven wick for one of looser texture and of a spongy character. In the investigation of this particular branch of the subject, Sir James Douglass informs me that a great deal of the success attained is due to Mr. Henry Defries, who expended a large amount of time and made many experiments in his efforts to produce a satisfactory wick. His perseverance and intelligent perception of the requirements were ultimately rewarded, and a wick was produced in every way suitable for mineral oil consumption. The theory of using a wick is that it should not be burned; it should act merely as a vehicle for bringing up oil to be converted into vapour, and this vapour only should be burned. That is the theory, but the practice falls short of it. Most wicks get burned and carbonised more or less. And what is the consequence? With carbonised wicks the tendency is for the gas-making action to be arrested, because the charred and cindered part of the wick offers a decided obstruction to the upward passage of the oil to the flame. If the oil cannot get past this obstruction, the flame cannot be maintained, it gradually diminishes, and before long goes out. Moreover, the burning of the wick itself communicates heat to the metal of the wick case, and with a volatile oil this would introduce a rather serious element of danger.

In this connection I may, perhaps, conveniently call your attention to what appears to be an important departure taken by the Broxburn Oil Company. Out of the burning oils section of their distillate from crude paraffin they cut a narrow fraction of oil of a very homogeneous character, with a very limited range of boiling points, but flashing at 100° F. This oil, it is found, lends itself to more perfect combustion than any mineral oil yet known. The processes of creeping up the wick, of forming and burning the oil vapour, are so perfectly effected that the wick itself is not carbonised, and only requires renewing at very long intervals. The lamp you see burning here was lighted on Thursday last, at 12 o'clock, and has not been put out since that time. Every morning the oil cistern has been replenished, but neither the wick nor the light are materially affected.

On the 30th of June last, an Argand burner with this oil, was lighted at 8 a.m., and burned day and night continuously until the 22nd July, when it was put out for want of oil. It burned 532 hours continuously, and at the end the wick, which is now on the table, was clean with very little char upon it.

In certain conditions this may be a very valuable kind of oil for lighthouses, but its flashing point is low for such service. For domestic lamps it may possibly be applied very usefully, for many would consider it a great advantage to keep one wick in a lamp for weeks together without trimming or renewing it. Here is a domestic lamp which Mr. Love, the manager of the Broxburn Oil Company, to whom I am indebted for much useful information, has had under trial for three weeks; the wick has not been changed, the lamp has been lighted every morning and burned for about seven hours, the reservoir being filled daily. Sir James Douglass is sanguine that he can successfully use this oil for illuminating a new lighthouse shortly to be placed at the entrance of the River Usk in Monmouthshire. This light will not be under the constant attendance of a keeper, and the supply of oil to the burner will be automatic, a reducing valve being introduced between the oil reservoir and the burner to render the flow uniform.

A further project Sir James has in view is to use this oil for the illumination of buoys at sea, instead of storing in them compressed gas as now. This project is, however, at present only in the region of experiment.

This leads me to mention another kind of mineral oil light, which has proved very serviceable on the Swedish and Norwegian coasts, which has also been adopted for lighting the Danube entrances, and in several instances in Scotland, at Stoneness in the River Thames. This light burns automatically without a wick at all, and is alight all day as well as all night. The light is produced by the combustion of very volatile petroleum spirit, which gives off vapour at all temperatures. The burner is fed automatically from a reservoir containing a sufficient quantity of spirit to last until it is replenished—perhaps once a fortnight. This light is visited occasionally, only to see that there is a sufficient stock of spirit in the reservoir, and that the automatic action is perfect.

Soft paraffin wax has also recently been submitted for trial as to its suitability for lighthouse purposes. It is now being used in what are known as the Cera lamps on board ships, and, to a limited extent, for domestic purposes. It has many advantages. When carefully freed from oil it requires less air for its combustion than other oils, and is therefore less liable to smoke under unfavourable conditions of burning. It gives more light than colza and other oils, is absolutely safe at a flashing point of 340° F. But it requires special arrangements to keep it fluid, and trouble in melting it in the first instance. For lighthouses purposes, it is not obvious that it can compete with the mineral oils, as now used, especially as regards price and facility of employing it; but the lighthouse authorities will no doubt await further developments of the application of this material with interest.

From time to time oils of various character have been submitted for trial, with a view to their being used for lighthouse purposes; but the paraffin and high-test petroleum have not been excelled, as regards efficiency and suitability, while, in respect of economy, they cannot be beaten. It will, doubtless, be observed that the Russian oils do not appear to have been brought seriously into competition with the paraffin and high-test American petroleum. Possibly it has not been considered worth while to cut out of the burning oils produced the comparatively small quantity of special oil adapted for lighthouse and lightship requirements; but there can be no doubt that the Trinity-house Corporation, and other lighthouse authorities, will gladly welcome any further competitor to supply their requirements; and I trust that the explanation of such requirements which I have offered to you this evening may be of service in making more widely known the special needs of the service, and in possibly stimulating the production of still more efficient and economical illuminating agents.

The supply of crude petroleum all over the world is very large, and, as the demand increases, the supply appears to be maintained; but should there come a time when the liquid petroleum resources show signs of exhaustion, the manufacture of paraffin can be continued, so as to supply the wants of the world for practically a unlimited period, seeing that bituminous shales exist in all parts of the globe in great abundance. It is much to be hoped that legislation will not do anything to cripple these important trades, but will allow full and free facilities for the transport and storage of all mineral oils which are admittedly safe for general use; but will, at the same time, in the interests of the general public, put such restrictions on the traffic in, and the use of, oils which give off dangerous vapours at temperatures below 100° F. (Abel test) as will prevent such oils being distributed all over the country for general use. In the Inflammable Liquids Bill of last Session, the distinction drawn between dangerous and safe oils did not appear to be so clear as it might be, and that the safe lighthouse oils as now used would have been subjected to the restrictions applying to really dangerous oils. It might perhaps be desirable to enact that every retailer of mineral oil should inform the buyer of the flashing point of the oil, for that is, without question, the one simple and intelligible test of its safety or otherwise. At the present time no one really knows what is sold over the counter as mineral oil.

It may be of interest to state that the samples of all oils submitted to the lighthouse authorities with tenders are subjected to severe tests to ensure only the very best quality of oil being supplied. The burning test lasts 16 hours without break, and no trimming of the wicks is allowed during that period. While the burning test is going on, photometrical observations are made after 4, 8, 12, and 16 hours, the mean of all being taken to indicate the real value of the illuminating power of the oil as burned in the test lamps. Of mineral

oils the specific gravity and flashing point are carefully ascertained, and each oil is subjected to fractional distillation to show the range of temperature at which the whole is distilled over, and the proportions distilling in uniform fractions between those limits. For paraffin the specified range is between 302° and 572° F.; for the heavy mineral oil a much narrower range is specified, viz., between 530° and 660° F. Further tests are made as to the oil remaining liquid at a low temperature; as to the effect of the 16 hours' burning on the wicks; as to the relative consumption, and a comparison with the sample of the oil accepted in the preceding year. When a contract is made for the oil supply every delivery under such contract is carefully tested to determine that oil supplied is in all respects equal to the sample upon which the contract was taken, and no oil is accepted which does not in all respects come up to the contract sample. When very high-priced mineral or vegetable oils were the illuminating agents for lighthouses, it was necessary to keep a strict watch on the expenditure. On the one hand it was requisite to ensure that a proper quantity of oil was used each night to maintain an efficient light; and on the other it was necessary to prevent waste, or possibly fraudulent dealing with so costly a commodity. Therefore a very elaborate system of accounting for every gill sent to the lighthouse was introduced, and is kept up to this day, although the value involved is very small now as compared with former days. The maintenance of a never failing supply of oil at each station is one of the most important obligations of the officers of the Lighthouse Boards, and to the credit of the service it may be stated that there is no instance on record of a lighthouse or a lightship having been unable to show lights at night through want of oil.

In the majority of cases the mineral oil is kept at the stations in tin-lined iron cisterns, but Sir James Douglass has in some recent instances recommended underground tanks built with rubble and cement, and lined with sheet lead. Such tanks are designed to contain at least twelve months' oil, and where they are constructed have given much satis faction.

The annual deliveries of oil to the stations on the English coast are made by the attendant steamers. One in particular is detailed for the mineral oil bnsiness. Consignments of varying quantities are made to be taken on board this vessel at different ports, and the small steamer takes to each lighthouse its annual supply. The work of delivering the oil is often delayed or made hazardous by the weather, and at the best of times is attended with much labour and difficulty.

In concluding my paper, I beg to say that the advantageous position now occupied by the authorities in respect to lighthouse oils is due mainly to the development of the mineral oil industry, through the enterprise of Mr. James Young, and those who encouraged and helped him in his early efforts; to the subsequent endeavours of those concerned in the mineral oil trade to meet the requirements for lighthouses, &c.; and to the desire of the lighthouse authorities, with their officers, to avail themselves at all times of new methods and improvements for the benefit of the important service over which they have control.

I must now thank you sincerely for your patience in hearing me, and ask you to forgive my many shortcomings. I have endeavoured to present the matter to you in a non-technical manner, and simply from the practical point of view, as affecting the service with which I am connected.

DISCUSSION.

The CHAIRMAN said Mr. Edwards had made this subject, although a technical one, extremely interesting. It was quite clear that mineral oils must in time beat the vegetable oils, on account of their chemical composition, the ingredients in the latter not being all combustible, but consisting of fatty acids and glycerine. Mineral oils, on the other hand, were nearly of the same composition as olefiant gas, the illuminating constituent of coal gas, with the addition of a little more hydrogen. They were therefore sure to win in the end; it was merely a question of manufacturing them safely. It was curious also that this was one of the oldest oils described in history, though it had been forgotten. It was only in 1846, when visiting one of the coal mines belonging to his brother-in-law, that he noticed this peculiar liquid pouring out of a portion of the strata, that it occurred to him it was worth investigating. In the Bible, and especially in the Apocrypha, this substance was constantly referred to, sometimes under the name of petroleum, *petri oleum*, the oil of the rock. When the spies were sent by Moses into the land of Canaan, they returned bringing wheat, grapes, honey, and oil flowing from the rock. Again, in the first chapter of 2nd Maccabees, there was an extraordinary account given of an experiment with petroleum. Nehemiah, after conquering the Persian territory, was anxious to find where the Priests of the Sun hid the sacred fire, and he offered some descendants of the priests a large

reward to show it him. They took him to a cave where there was no fire but a thick water, and he took of that water and poured it over the burnt sacrifice and filled the trenches round the altar with it. When the sun came from behind the cloud—(he did not mention the burning glass, but he must have had one)—the water took fire, the burnt sacrifice was consumed, and the water in the trenches was licked up. Therefore he called that thick water naphtha, which meant purification, and that was the origin of the word naphtha, which was still commonly applied to native petroleum or to the lighter portion of the distillate. It was frequently referred to under the name of thick water or rock oil, as when it was said, will the Lord not be satisfied with so many bullocks, and a river of oil flowing from the rock. It was also often called salt, as in the text, "Thou shalt not have a burnt sacrifice that is not smeared with salt;" the sacrifices being smeared with petroleum and set on fire. Again, "When the salt has lost its savour it is only fit to be trodden under foot;" but salt never lost its savour, and was never fit to be trodden under foot. But the salt of the earth, which was pretroleum, lost its essence by exposure, and left asphalte as the residue, which was made even in old times into pavements to be trodden upon. The Dead Sea is to this day locally called "Lake Asphaltites." The poor little spring of oil, which he introduced to his friend, James Young, and induced him to manufacture into burning and lubricating oil, soon dried up, but the industry then set on foot had grown to be very mighty indeed. From it had come not only a vast chemical industry in England, but it had led to the vast commerce in natural petroleum in America and Russia. It extended from the Caspian sea right away to the Himalayas, and there need be no fear of the supplies being exhausted. Baku was comparatively a small place, but the whole Caspian sea had petroleum beneath it, and sometimes it floated up to the surface, and could be set fire to. One day Mr. Young brought him, in great dismay, some of his oil, which—it being very cold weather—had become thick and turbid, and asked him what he should do, as the oil evidently would not keep. He said that must be the substance which Reichenbach described under the name of paraffin wax, and he asked him to get him enough of it to make a couple of candles. He produced it by freezing, though each candle cost £1, and he lit up his lecture room at the Royal Institution with those two first paraffin candles, and announced then that they would be the parents of a great candle industry. He was glad to say that his friend James Young died with an enormous fortune, which came chiefly from paraffin candles, for they paid much better than oil. Some years ago there was an Exhibition at Glasgow, and he found there a bust of himself in paraffin, which was very gratifying to him, as showing that the paraffin manufacturers had not forgotten the author of their industry. It was quite possible, by chemical means, to convert the lighter kinds of petroleum oils into heavy oils which would be quite safe; he had done it himself, and though it had not yet been done commercially, no doubt it would some day if it were necessary. This rock oil was no doubt used by the ancients for torches; because although you often read of candles in the Bible, candles were not then known, but torches were, and no doubt this oil was used for the purpose, and probably the first lighthouse ever put up—that on the island of Pharos—was illuminated by a fire kept up with asphalte and other combustibles, rock oil included.

Mr. Boverton Redwood said there was no doubt of the immense stores of petroleum in the world, which would last, probably, for centuries. Having had the opportunity of visiting some of the principal oil fields, he had been much impressed with the fact that up to the present time, notwithstanding the immense growth of this trade, we were probably only on the fringe of an infinitely greater development. Looking to the extent to which mineral oils were likely to be employed in the manufacture of illuminating gas, for the purposes of liquid fuel, and in other directions, this might really be termed the age of petroleum. Some of Mr. Edwards's observations with regard to the flashing point of these oils he must venture to call in question, because he understood him to adversely criticise the standard which had been adopted by the legislature, not only in connection with the introduction of the Abel test, but in the inception of the petroleum legislation. The system of testing first adopted was known as the open test, the flashing point in the open cup being 100° F. When the Abel system was legalised by the last Act, one of the most important points snbmitted to Sir Frederick Abel for consideration was the sufficiency or otherwise of the then existing test-standard. He had the honour of being associated with Sir Frederick Abel in some of his experimental work, and well remembered his expressing in his report a very distinct opinion that there were no grounds for considering that the minimum legal flashing-point was not calculated to afford adequate protection to the public; therefore, in fixing the new standard at 73° F., he avowedly did so because it was as nearly as possible the equivalent of the test which had hitherto been in use. A very elaborate investigation was also made in Germany, and when the Abel-Pensky system was adopted, which was substantially Abel's with a mechanical arrangement for the introduction of the light, the standard was fixed at 21° C., which was lower than the English standard. Again, when the subject of petroleum testing in India was being considered, the standard was fixed at substantially the same point as in this country, although the climatic conditions might be thought to require a higher standard. The definition provided that if the whole of the samples were of uniform quality, if none flashed below 70°, and the average was 73°, they might be passed as safe for use in lamps; if a single sample only were

tested, however, the standard was fixed at 78°. With regard to the relation between the flashing point and safety or danger in use, he was rather surprised that Mr. Edwards had not referred to the experiments made by the Commission in Berlin, or to those of Sir Frederick Abel and himself. Substantially it was found that a lamp might be said to be in the safest condition when the space above the oil in the reservoir was filled with vapour. If a lamp were of dangerous construction, having a free communication between the flame and the reservoir, and you tried to ensure safety by using oil with a high flashing point, you might have safety or you might have danger. Oil of a low flashing point obviously volatilised more readily, but that very condition tended to keep the upper portion of the reservoir charged with so much vapour that, even if the flame was communicated to it, there was simply ignition, but no explosion, for which a certain proportion of air was necessary. With an oil that volatilised more slowly, there was greater risk of getting an explosive atmosphere. For some years Sir Frederick Abel and he had, through the courtesy of Mr. Alfred Spencer, been afforded the opportunity of examining the *débris* of lamps with which accidents had occurred in the metropolitan district, and, where possible, the oil which had been used; and at a later date, in accordance with the desire of Colonel Majendie, they had made further investigations into lamp accidents. It was found that some of the most violent explosions occurred with oils of comparatively high flashing point, and the whole result was to confirm the conclusion previously arrived at, that safety could not be ensured by insisting on the use of high flashing oils only. With a dangerous lamp you might have an accident with almost any kind of oil; if the lamp were of safe construction, it would be next to impossible to have an accident with oil of any sort. He was not advocating the use of oil of extremely low flashing point, but the experience of 30 years had conclusively shown that the present standard of 73° F. was sufficiently high to insure the public safety. Mr. Edwards had given the result of a few experiments with different oils, but experiments were being made by the million every night, and the results of a few isolated experiments were not so convincing. It was quite possible to produce an oil which had a high flashing point, a low specific gravity, a high capillarity, which would flow and burn very well, and would not cause any abnormal heating of the lamp, but such oil could only be supplied in comparatively small quantities; and unless it could be shown to be essential to the safety of the public to have an oil of that description, it would be unwise to take any steps, by legislation or otherwise, which would have the effect of limiting the supply in that direction. He quite agreed with Mr. Edwards that there was no insuperable difficulty in manufacturing from American or Russian petroleum an oil suitable for lighthouse purposes; but it was necessary to take only a small fraction of the total distillate; and possibly it might answer the purpose of the Scotch refiner better to manufacture such an oil than the Americans and Russians. Exception had been taken to the definition of "inflammable liquid," in relation to lighthouse oil, in the recent Inflammable Liquids Bill, but it was worthy of note that this point was not raised when the Bill was under discussion, by specially appointed delegates of the trade, including representatives of Young's Paraffin Oil Company, the Broxburn Oil Company, and others. If the title of the paper had been rather more general, he thought there would have been a much larger attendance; but as regarded oils for lighthouse purposes, he had nothing but commendation for the manner in which the subject had been treated.

The CHAIRMAN having proposed a vote of thanks to Mr. Edwards,

Mr. S. S. BROMHEAD pointed out that the temperature in the lamps experimented on would vary according to the material of the reservoir. If it were of metal, the oil would get to a much higher temperature than if it were of glass, with a layer of plaster between it and the burner. They were all delighted to find that the Trinity Board had at last recognised the value of mineral oil, but he could remember, some twenty-five years ago, when the manufacturers pressed it upon them in vain, although the oil was even then in general use. An oil which was safe enough for domestic use ought to be safe enough for a lighthouse; and if the Board insisted on such a high standard that the manufacturers had to appropriate the cream of their product for this particular purpose, it would tend to lower the average quality of that supplied to the public at large.

The vote of thanks having been carried unanimously,

Mr. PRICE EDWARDS, in reply, said he had simply endeavoured to present the facts as they came under his notice as a public official; he had not attempted to deal very technically with them. He had the very highest respect for the opinion of Mr. Redwood, who had devoted the best part of his life to this subject, but he must repeat that what he had stated were simply facts; whether his experiments would be borne out by thousands of others he could not say, but they were conducted in a perfectly *bonâ fide* way. One gentleman had spoken in favour of glass for lamps; but others objected to glass lamps as being dangerous, because they were easily broken, and would allow the vapour to escape. If there were vapour contained in any receptacle at a higher temperature than the flashing-point of the oil, there was a source of danger; for it only needed to be liberated to inflame, or, if a flame got to it, to explode the lamp; and these facts, having come incidentally under his notice, he thought it his duty to mention them.

Correspondence.

DUST AND FRESH AIR.

I regret that my inability to hear in a large room prevented my attending the reading and discussion of Mr. Teale's paper. The closed ash receptacle under the grate has been used by myself for fully thirty years, by the simple expedient of bending a sheet of perforated polished brass to fit the front opening under the fire receptacle; and the addition to this of a strip of sheet iron between and behind the two lower bars of the fire, entirely prevents dust from falling on the hearth, making a perfectly clean, hot, and almost smokeless fire. Hundreds of copies of my arrangement have been made, and many are in use at the present time.

With regard to the use of velvet for the exclusion of dust, this has been used from time immemorial under glass shades; but its use for cupboards, &c., which are to be opened at intervals, however pretty in theory, is utterly impracticable, owing to the fact that it is impossible to obtain such wood as must be used in a condition which prevents its alteration in shape. For all important work of this class I use Spanish mahogany, which has been drying for ten or twelve years; but even this, if worked, or even planed, will begin again to alter its shape. When it will stop doing this I cannot tell, but I believe I am within the mark in stating that it does not settle down in another ten years, although it is pretty well acknowledged by experts that old Spanish mahogany changes its form less than any other wood known, and less than any artificial material which can be used in its place.

Our practice of opening every window in the house to its full width on all possible occasions, as an absolute necessity for keeping a house sweet and healthy, would hardly accord with the proposed system of controlled and limited ventilation; and, speaking from some experience, I should prefer the open windows and the "blacks."

The method of double glazing suggested is expensive, requires periodical attention, and is totally inapplicable to existing window frames. An equally good result can be obtained in ordinary window frames, by the use of two sheets of glass, set in with a putty, made by mixing whiting with what is known in the trade as "copal bottoms," *i.e.*, the thick waste from the bottoms of copal varnish casks. This putty is absolutely air and dust tight, making a perfect joint with the wood and glass, the latter having ample elasticity to provide for the expansion and contraction of the enclosed air. Any appreciable space between the sheets is quite unnecessary in practice.

It will be seen that I have traversed the same ground as Mr. Teale, with the essential difference that I have worked to existing conditions, and obtained the same result, at a very small expense, except the exclusion of "blacks' from the house; and, as regards any system yet invented, I may honestly say I prefer the "blacks" along with unlimited ventilation.

THOS. FLETCHER.

Warrington.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 17.—Capt. F. E. YOUNGHUSBAND, "The Pamirs." General Sir GEORGE CHESNEY, K.C.B., C.S.I., C.I.E., will preside.

FEBRUARY 24. — ERNEST HART, "Ancient and Modern Art Pottery of Japan." Prof. WILLIAM ANDERSON, F.R.C.S., will preside.

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

FEBRUARY 16—LEWIS ATKINSON, "The Forthcoming Exhibition at Kimberley." The Hon. JOHN X. MERRIMAN, M.L.A., will preside. The paper will be illustrated by lantern slides. 8 p.m.

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru." 8 p.m.

APRIL 5.—The Rev. JOHN McLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19. — JERVOISE ATHELSTANE BAINES,

I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets." Sir PHILIP CUNLIFFE-OWEN, K.C B., K.C.M.G., C.I.E., will preside.

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks."

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. GEORGE FORBES, F.R.S., "Developments of Electrical Distribution." Four Lectures.

LECTURE IV.—FEBRUARY 15.—Generators of electricity by water-power and by steam obtained from destructors—General account of destructors—Hydraulic accumulators—Utilisation of local circumstances—Probable developments of electric distribution in the immediate future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. George Forbes, "Developments of Electrical Distribution." (Lecture IV.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. W. Grover, "An Explanation of the London Water Questiou."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Rev. J. J. Lias, "Miracles and Science."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Whitworth Wallis, "Wanderings in Sicily, the Island of the Golden Shell."

TUESDAY, FEB. 16 ... SOCIETY OF ARTS, John-street. Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Lewis Atkinson, "The Forthcoming Exhibition at Kimberley, South Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture V.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. A. H. Curtis's Paper, "Gold-Quartz Reduction Machinery."

Statistical, School of Mines, Jermyn-street, S.W., 7.45 p.m. Mr. L. L. Price and Dr. J. C. Steele, 'The recent Agricultural Depression as exhibited in the rental of an Oxford College, and the financial position of a leading London Hospital."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Zoological, 3, Hanover-square, W, 8½ p.m. 1. Mr. F. E. Beddard, "Contributions to the Anatomy of the Anthropoid Apes." 2. Mr. A. G. Butler, "On a Collection of Lepidoptera from Sandakan, N.E. Borneo." 3. Mr. G. A. Boulenger, "Third Account of the Fishes obtained by Surgeon-Major A. S. G. Jayakar at Muscat, East Coast of Africa."

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, FEB. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Capt. F. E. Younghusband, "The Pamirs."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1891." 2. Hon. F. A. Rollo Russell, "The Untenability of an Atmospheric Hypothesis of Epidemics." 3. Mr. Henry Harries, "The Origin of Influenza Epidemics." 4. Dr. Ernest H. Cook, "Note on a Lightning Discharge at Thornbury, Gloucestershire, July 22nd 1891."

Microscopical, 20, Hanover-square, W., 8 p.m. Address by the President, Dr. Braithwaite.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. F. P. Cembrano, "Public Exhibitions."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. Booth, "Gas Producers."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, FEB. 18...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Percy Groom, "Bud Protection in Dicotyledons." 2. Mr. F. Stephani' "Revision of Colenso's New Zealand Hepaticæ."

Chemical, Burlington-house, W., 8 p.m. Mr. Horace T. Brown, "A Search for a Cellulose Dissolving (cyto-hydrolytic) Enzyme in the digestive tract of certain Grain-feeding Animals. 2. Prof. Tilden, "Limetbin."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Vivian Lewes, "Illuminating Flames."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "Some Recent Biological Discoveries."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 11, Chandos-street, W., 8½ p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, FEB. 19...United Service Institution, Whitehall-yard, 3 p.m. Major C. F. C. Beresford, "The Telephone at Home and in the Field."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Percy Frankland, "Micro-Organisms in their Relation to Chemical Change."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Annual General Meeting. 2. Prof. S. Thompson "Supplementary Colours," and 3. "Modes of representing Electromotive Forces and Currents."

Geological, Burlington-house, 3 p.m. Annual Meeting.

SATURDAY, FEB. 20 ... Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Rev. G. F. Browne, "Early Christian Art." (Lecture II.)—Scotland and Man.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture II.)

Journal of the Society of Arts.

No. 2,048. Vol. XL.

FRIDAY, FEBRUARY 19. 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The fourth and concluding lecture of the course on "Developments of Electrical Distribution" was delivered by Professor George Forbes, F.R.S., on Monday evening, 15th inst.

On the motion of the Chairman, the thanks of the meeting were voted to Prof. Forbes for his course of lectures.

The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 17th inst. Present: The Attorney-General, M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Professor James Dewar, M.A., F.R.S., Major-Gen. J. F. D. Donnelly, C.B , Sir Henry Doulton, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. Malcolm Kennedy, C.B., J. Fletcher Moulton, Q.C., F.R.S., Sir Owen Roberts, M.A., F.S A., Professor W. C. Roberts Austen, C.B., F.R.S., with Sir Henry Trueman Wood as Secretary.

TEXTILE COMMITTEE.

A meeting of the Committee on Textile Manufactures was held on Friday, 12th inst. Present:—Mr. Charles Malcolm Kennedy, C.B., Chairman of the Committee; Mr. J. D. Barbour (Belfast); Mr. C. E. Bousfield (Leeds); Mr. Frederick Ellis (Dewsbury); Mr. William O'Hanlon (Manchester); Sir Owen Roberts (Clothworkers' Company); Mr. Thomas Wardle (Leek); and Sir Henry Trueman Wood (Secretary of the Royal Commission).

ELECTRICAL DEPARTMENT.

The following circular letter from the Chairman of the Electrical Committee has been issued:—

Society of Arts,
John-street, Adelphi,
London, W.C.,
February, 1892.

Gentlemen,—The Electrical Committee are anxious that the Electrical Department of the Exhibition should contain a good representation from this country.

The British exhibit will include a historical collection as well as the contributions which will be sent in by commercial firms. In addition, it is hoped that a portion of the electric lighting of the Exhibition may be carried out by some British firms, and the Committee think that the arrangements of a complete lighting station on the English method could advantageously be shown at Chicago.

From the English point of view it is specially desirable to show how large a share English electricians have had in developing electrical science and its practical applications. The first electrician was an Englishman, Gilbert. It was in England that a practical telegraph line was first worked out by Ronalds in 1816. There are no names more closely associated with the early development of the science of electricity than those of Davy and Faraday. The introduction of telegraphy must inseparably be connected with Cooke and Wheatstone; while the early history of the dynamo would be incomplete indeed without reference to Wilde and Holmes.

In England, electricity was first applied to the working of railways, and here nearly all the submarine cables of the world are made.

It is hoped that arrangements may be made for showing the fine collection of historical apparatus in the possession of the Post-office, and this will be supplemented by contributions which will be sought from many other sources.

On the commercial side, whilst there is no disputing that practical electric lighting has made greater progress in America than in this country, there is yet much that England can show electricians on the other side of the Atlantic. The domestic uses of electricity, and its artistic application, are matters in which they confess themselves to be less than we are; and probably many firms who make this a speciality will find it to their interest to show in the Exhibition electrical fittings and the manner of their application.

It is especially to be remembered that the Exhibition will be visited by numbers of foreigners, and especially by many persons from our own Colonies; and it is important that English electricians should not miss this opportunity of strengthening and increasing their hold on Colonial trade, since it is quite certain that a strenuous effort will be made by American manufacturers to get this important source of revenue into their own hands.

Another department in which the United States exhibit will certainly be deficient is that of electric railway signals. The methods on which American railways are worked, do not, as is well known, require the very complete system of signalling apparatus employed in European countries, but this system is now being introduced into America, and will probably supplant the methods now in use. There is, therefore, a very favourable opportunity for manufacturers of this class of apparatus to bring themselves before the notice of American customers.

Another important department which ought not to be neglected is that of electro-metallurgy. Here also English inventors will probably find it to their advantage to bring their inventions under the notice of American metallurgists.

A special building in Jackson-park will be devoted to the Electrical exhibits. The size of this building is 700 feet by 350 feet, enclosing an area of 250,000 square feet. The space provisionally allotted to Great Britain in the building is 20,000 feet.

It is understood that all the buildings as well as the grounds will be lighted at night.

Applications for space in the British Section must be made upon forms to be obtained from the Secretary of the Commission, Sir Henry Trueman Wood, at the Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, not later than February 29th, 1892, and addressed to the Secretary as above.—Yours faithfully,

W. H. PREECE,
Chairman of the Committee.

RAILWAY COMMUNICATION.

At the meeting of General Managers of British Railways, held at the Clearing-house on Thursday, the 11th inst., it was decided that the railways would carry goods for British exhibitors at the Chicago Exhibition, to and from the port of shipment, at half rates. The American railways will charge their usual rates to Chicago, but will bring back the goods free at the close of the Exhibition. Many of the principal steamship companies have reduced their rates considerably, and will take freight for the Exhibition at 11s. per ton. Many of them have also consented to adopt a reduced passenger tariff for exhibitors and their *employés*, certified as such under the authority of the Royal Commission.

CANADIAN COMMISSIONER.

The Canadian Government have appointed Mr. William Saunders Commissioner for the Dominion of Canada at the World's Columbian Exposition.

The word "Praxiteles" has been registered at the General Post-office as the telegraphic address of the Society of Arts, and of the Royal Commission. Telegrams may therefore be addressed "Praxiteles, London."

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 11, 1892; Lieut.-Gen. Sir ANDREW CLARKE, G.C.M.G., C.B., C.I.E., in the chair.

The paper read was—

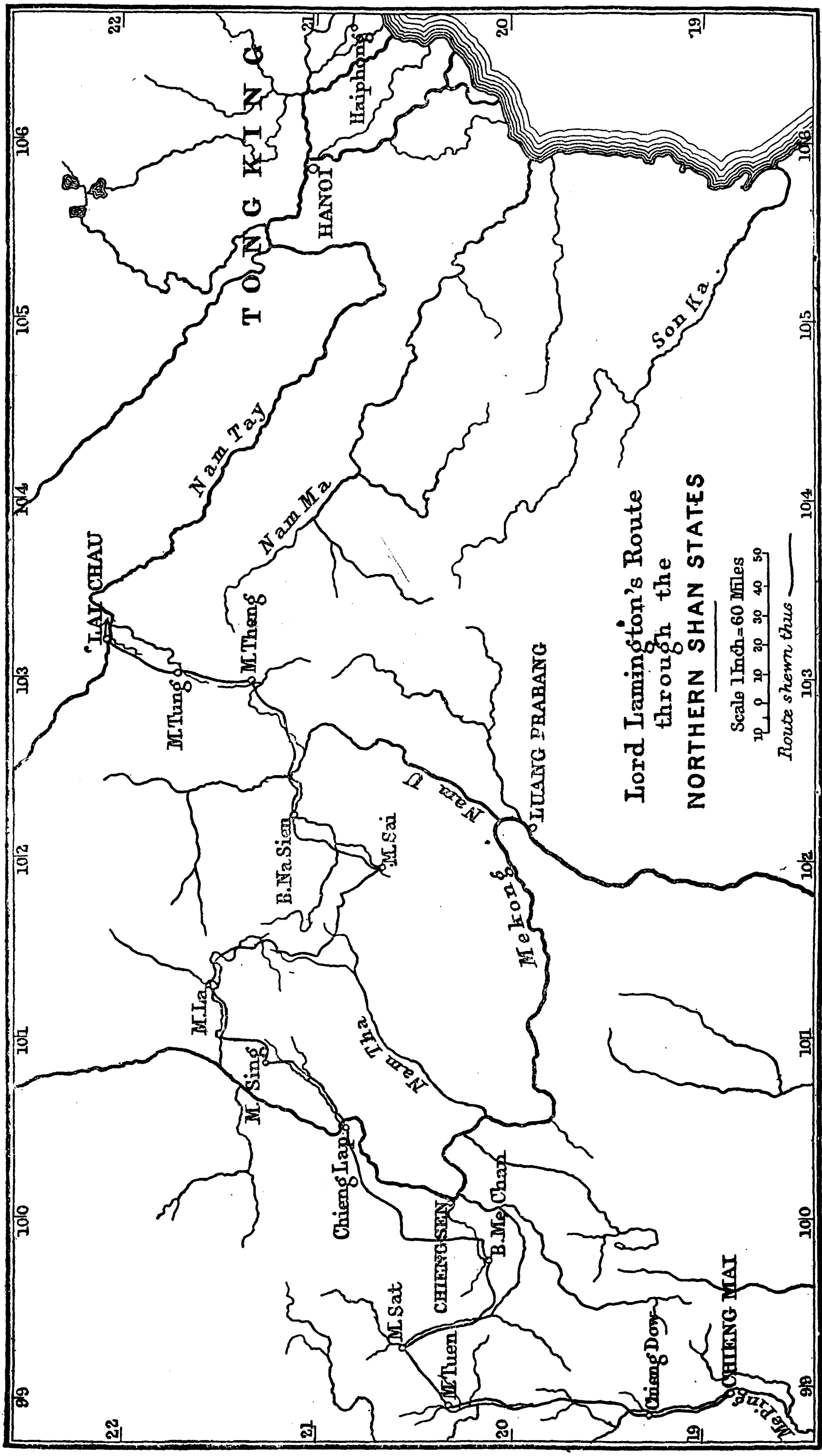
RECENT TRAVELS IN INDO-CHINA.

By LORD LAMINGTON.

The kingdom of Siam, lying as it does off the track of the chief line of steamers, is a country not often visited by Europeans; but this will be changed, as the last five or six years have witnessed a considerable increase in the number of European traders. It may be assumed that once the globe-trotter realises he can see Oriental life with most of its essential characteristics retained, he will not grudge the four days spent in going from Singapore to Bangkok.

The chief part of the town lies on the western or left bank of the river, but its originality is being destroyed by the construction of roads and houses partaking of European design. It is on the other bank where locomotion is only possible by boat through a network of intricate canals, embowered by tall palms, ferns, and bamboos, that it might be well entitled the Venice of the East. The houses, almost hidden in the jungle, are of bamboo, built on piles to raise them above the mud. For that matter all the houses in Siam and the Shan States are raised above the level of the ground, and are entered by ladders. A large population live in house-boats moored to posts on either side of the river.

I witnessed some of the Royal processions, both by land and on the river; the former are curious from the quaint old dresses that are intermingled with the modern uniforms of the



Lord Lamington's Route through the NORTHERN SHAN STATES
Scale 1 Inch = 60 Miles
10 0 10 20 30 40 50
Route shewn thus
F. S. Weller.
TONG KING
HANOI
Haiphong
Son Ka
Nam Tay
Nam Ma
LAI CHAU
M. Theng
M. Tung
LUANG PRABANG
Nam U
Mekong
B. Na Sien
M. Sai
M. La
M. Sing
Nam Tha
Chieng Lap
CHIENG SEN
B. Me Chan
M. Sat
M. Tuen
Chieng Dow
CHIENG MAI
Me Ping

naval and military forces; the water *fêtes* are fascinating from the many long canoes that take part in the display, and which are propelled by some seventy men, whose gilt paddle blades glisten in the sun. The whole scene is one of gorgeousness and splendour. The King, with his crown on and in his robes of State, sits on a high throne under a golden canopy in the largest canoe. At night, too, the river illuminations are like a fairy scene, and at all events in one respect differ from our Crystal Palace displays, as some of the fireworks in Siam are musical.

I spent a pleasant fortnight in Bangkok, and was received courteously by the King. Though the Europeans there affect some indifference if not contempt for all that is to be seen in Bangkok, to the ordinary traveller there is much for him of interest in the manner of life of the people. It may be some consolation for those who in this country deplore the degeneracy of our times, as marked by strikes and the difficulty of getting good servants, to know that in Bangkok a row of houses have long remained in an unfinished state owing to a strike of the Chinese, and that the second is a grievance which is constantly aired.

I left Bangkok in the *Chow Phya*, a stern-wheeled steamer, owned by a British Company, which runs, so long as there is sufficient water in the river, as far as Paknam Po. The river bank was fringed with bamboos, and amid them houses, or rather huts, now and again showed themselves. At the back of these houses are extensive paddy plains. Teak and paddy are the two great articles of Siamese trade; and, for either of these, a dry season like the one they had last year means serious loss. The dryness affects the teak, in that the logs cannot be floated out of the forest down the creeks; and even in the river the shallows are so numerous that the cost is enormously increased by the labour of working them down. After the first two days, the steamer was constantly grounding. Then arose a wild scene of confusion. The steamer chiefly pays by towing up empty rice-boats; these are astern, in four lines, with perhaps from four or five boats in each.

As soon, then, as there is a sudden check, or when rounding a sharp bend of the river, the boats dash and grind up against one another, or against the bank, the family on each boat yell and shriek, and jump on to the roof, made of bamboo and plantain leaf, endeavouring to avoid the danger of being swamped and crushed.

We took four days to reach Paknam Po, the river banks being monotonously flat all the way. I here changed into a boat provided for me by the Chinese agent of the Borneo Company. I took charge for him of some money that was needed by other agencies up the river; nor was he sorry to be quit of it, being always fearful of being robbed. As a matter of fact, robberies occur only between the natives, and an attack on a European is unheard of. This Chinaman described the people as very apathetic and indifferent as to who their rulers might be. Their only dread is of compulsory service, to which, in addition to a regular annual amount, they are always liable to be called on to do. One instance was related to me of how a certain town was named to supply men for military purposes, but the people heard of this, and the whole male population discreetly vanished into the jungle.

When a prince is on his travels, every district through which he passes is called on to supply him with food and transport, and it is not uncommon if the news gets wind for the owners of boats to request a European to take temporary charge of them. Much as the people dislike this system, they evince no desire of working for themselves. This is to be partly accounted for by the impossibility of their retaining money in their own possession, if once it becomes known that they have any laid by—for the practice of farming the taxes naturally results in great oppression—and partly because the ease of living renders them careless as to the future.

When I was ascending the Meping, I experienced the greatest difficulty in obtaining boatmen, despite the liberal pay, and the fact that they might otherwise at any moment be called upon to work for some chief without reward. On one occasion a traveller to Chiengmai found that the crew whom he had engaged had paid substitutes to do their work, while the latter in their turn hired others; and thus packed away in one small boat were three crews, one of whom alone worked. The boats are covered in, and can be made very comfortable. A crew is usually composed of four men. They punt the boat, pressing the bamboo pole into the hollow of the shoulder, with their bodies bent double. The men are almost always Laos, and are capital workers when once they start. They are all tattooed about the middle, and often dispense with garments altogether. These tattoo marks are beautifully executed, and by

these markings, the Laos to the west of the Mekong acquire the title of "black-bellied," those of Luang Prabang, who are only now beginning to adopt the custom, have hitherto been known as "white-bellied." They have no hair on the face, unless it be a moustache resembling a scraggy tooth-brush, and their heads are shaven except on the crown, where the hair bristles straight up as if astonished at the extraordinary countenance below it. Cheap German looking-glasses beguile a great part of their time, as they gaze at their faces and carefully search for any hairs showing where they should not be. The men are amphibious, tumbling out of the boat on the smallest provocation. It was interesting to see raftsmen bringing down teak rafts. On a high scaffolding a man would watch for any shallows or obstructions, and give orders accordingly to the others. Some would be poling; but one man in the water behind, with a pole attached to the raft by a long rope, would, as soon as a particular direction were pointed out, swim off, and then planting the pole firmly into the river-bed, the rope would gradually tauten and the raft swing round on this extemporised pivot.

At Raheng I paid a visit to the Governor, but the interpreter not turning up our conversation was strictly limited; however he returned the visit in the afternoon under more favourable circumstances, bringing with him a present of a pig and chickens. Though I was only staying at the other end of the town or rather long straggling village, he had never before been such a distance. The main street was difficult to ride through without one's feet damaging the eggs or other commodities exposed for sale in the shops, whilst overhead bamboo shutters to keep off the sun gave unpleasant knocks on the head.

I continued my journey up to Chiengmai, and on the third day was making slow progress up the rapids. The delay was compensated for by the fine scenery; rocky cliffs of great height bordered the river, and every niche where a tree could find place for its roots was filled by some specimen of forest life. The worse rapids had to be surmounted by towing, at which all assisted. My own dress was adapted for getting wet, as it only consisted of a shirt and a short native skirt or sarong, and no boots or socks. Once the rapids passed, the villages became again more frequent; in some of them were deliciously sweet smelling flowers. There is an ingenious water-wheel used for irrigation purposes, and as it turns, instead of making a creaking noise, low melodious sounds are produced. The blades of the water-wheel are fashioned out of split bamboo, set at such an angle that they hold the water caught in going round till they reach the highest point of the circle, when the water empties itself into another bamboo projecting from the bank, thence it is conveyed and distributed wherever required.

After nearly a three weeks' journey I reached Chiengmai, the capital of the Laos country. Its population is put at 20,000, but I consider that a very high estimate. The inner town is surrounded by a high wall, in which are temples and houses with large compounds. The market is most varied, and the Laos graceful and charming to look at. Their dress consists of a longish petticoat with many horizontal stripes of different colours, a yellow shawl is thrown gracefully over the bust, and their hair, done up in a knot, is usually decorated with flowers. The American missionaries, who have established themselves here, enforce upon any converts they may make the wearing of tight-fitting white jackets. The effect is most ungraceful; and, if the senses are exercised in any way, I am sure it is not in the one desired. The people are themselves most modest, and this act of Mrs. Grundyism can only be to create in the mind suggestions which had no existence before. A new wooden bridge connects the two banks, but it was a matter of debate whether it would stand the floods, with teak logs crushing up against it. This is one of the very few bridges in the country. It is lamentable to see, both for the interests of the country and for the travellers' comfort, how the so-called trade routes are the veriest tracks in the jungle, made yet more difficult by the deepest muddy holes, boulders, fallen timber, and any other conceivable obstacle.

The Chief of Chiengmai gave me a representation of one of the Laos plays, followed by some of the national war dances. The performers are, in every case, women, and of his harem. They don't speak, but only act by gestures. This is chiefly done by the working of the wrists and hands. Their dresses are magnificent. The band do the chorus, and tell, or, more strictly speaking, relate the story. The musical instruments are very varied, those fashioned of strips of bamboo, stretched across a wooden framework, being, in my opinion, most silvery-toned and melodious. After a feast, I finished up the

evening by playing a game of cards called "pok," something of the nature of *vingt-et-un*. Some of the wives played, and apparently any of the public who liked to could join in. The faces of the natives whilst playing were a study of immobility.

Some description of the political position of the country would not be out of place, for Great Britain, of all European powers, has by far the largest interests at stake in Siam. She carries on the bulk of the trade in Bangkok; and hitherto at Chiengmai the only firm that has an agency there is the Borneo Company. Moreover, there are thousands of British subjects in the country. In Siam proper there are Malays, Chinese, and Hindoos; in Laos there are Burmese and Shans. These altogether number several thousands, and it is for their protection that we have a consul at Chiengmai, who, by treaty, has partial powers of jurisdiction in cases in which they are concerned, though it is a matter for regret that he has not equal powers as the consul at Bangkok. Our frontiers, which have been extended by our now holding all the old kingdom of Burma, are in course of arrangement with Siam; in fact, except for a comparatively small distance on the north, they have been practically agreed to. Laos territory used to merely own the suzerainty of Siam, but the latter is now imposing her authority to a much greater degree, not entirely to the satisfaction of the Laos. No doubt, however, Siam is wise to try and consolidate her tributary States. The French idea is to retrieve in Indo-China another India. Consequently every year sees them pushing on from Tonquin and the Annan coast. The very least they seek is the Mekong as a frontier, and for this no other authority need be quoted than that of M. Ribot, the Minister of Foreign Affairs, who recently made a statement to that effect in the Chamber. The new Governor-General of Tonquin, M. de Lanessan, in his work on Indo-China, considers the watershed between the Mekong and Menam rivers as the proper frontier. There is not the slightest validity whatsoever in any of these claims, but every year sees fresh expeditions being sent out for purposes of survey, commerce, or any possible excuse. The Mekong has been ascended last year by steamer as far as the first rapid, and its uselessness as a waterway has been fairly proved. This will not deter the French from including Luang Prabang as a possession, nor is it likely that any opposition would be offered, though there was a talk of the Siamese venturing to offer fight. It may be well asked what the French expect to gain, as the "hinterland" of the Annam coast to the Mekong is decidedly of a poor nature, unless it has mineral wealth. The answer, then, is that they expect to be able to put goods into Chiengmai, by way of the Black River, cheaper than the British can from Bangkok, or the Panthay traders from Burma. The idea is ludicrous, but that was the way in which the French accounted to me for their policy; if it is not that, they must have other and grander intentions.

To resume my personal narrative. Mr. Archer was about to take charge of a frontier survey mission, and I took advantage of his kindness to travel with him. I had to secure the services of a party of Panthays and their mules to take my baggage. These Panthays are Chinamen who had been driven out of Yunnan for rebellion, some few years ago, and had settled in Burma, carrying on trade, in the dry season, by caravan. They were fine tall men, and hardy. The way of loading their mules is peculiar; the baggage is strapped rigidly with long leather thongs on to a tree or trestle, and must be so adjusted that the weight on either side is equal. This is then lifted up by two men and placed on a pad on the mule's back, without any further fastening, and keeps its place by balance. This is the reason why the weights on either side must be carefully adjusted. After several trifling *contretemps*, we left Chiengmai on December 10th, 1890, and, in eight days, reached Meung Tuen. The country we went through was perpetual jungle, except on the rare occasion of passing through the paddy or rice fields of some village. If there were the population to work it, the area of cultivation might be vastly increased, and, from the dense wood on the hills, it may be imagined that the whole of the country might be rendered productive. We saw a certain amount of teak, but this, wherever it can be worked to a profit, is fast disappearing before the axe of the Burmese forester, and there are no attempts at replanting.

At Meung Tuen the escort and survey officials joined us from Burma; they had been suffering a good deal from fever. We were now a large party, as there was a Siamese representative and his escort. Subsequently, we were joined by a Laos Commissioner, and also a representative from Kyangtou, one of the Shan States.

Our course lay eastwards, over the divide

between the Salween and Mekong water-systems. As often as not the route took us up the bed of some stream, overhung by creepers, wild plantains, and the general wide luxuriance of tropical growth. Tiger and deer were plentiful, also monkeys. Birds might be heard flying away, but all animal life, from the density of the jungle, was rarely seen.

In three days we reached Meung Sat; the greatest elevation we had been over was about 3,300 feet, the altitude of the cultivated valleys being usually about 2,200 feet.

Meung Sat is a very small village, The plain is extensive. The Mekhok, a fine river some 60 yards broad, flows on the eastern side. The cold mists in the morning made us shiver, the thermometer registering 44°. This does not sound chilly, but the change after the heat of the day, when it was 88° or 90°, was trying.

The Musea tribe, who live on the hills, occasionally visited us, anxious to see the "lords of gold and silver." They live in the most secluded parts of the mountains, never allowing a stranger to approach their villages if they can help it. Otherwise they are nice, open-faced, little people, extremely expert with the cross-bow and arrow. They carry some of the latter poisoned in case of any danger. In every party of these people I came across, one or two of the number carried musical instruments in the form of a hollow gourd, in which are five bamboos; holes are pierced for notes. The music is soft, but melancholy. Our further route lay down the left or opposite bank of the Mekhok, and on January 1st we reached the village of Na Mon, which no white man had previously visited.

The antagonism of interests for the last decade has made the neighbourhood by no means safe. The outpost villages on either side were inhabited by men whom a sense of constant danger had made somewhat callous to the right of property. There was consequently nothing but an ill-defined foot-track, and even this had been unused for a year after the burning of Meung-Yon and Wying Chè villages by the Siamese last year. We had, therefore, to cut, and in a good many places to dig, our own road, for not far short of a hundred miles in all, extending on either side of Wying Chè. This resulted in a very serious loss of time, but as a compensation it induced the former inhabitants of the destroyed villages to return and rebuild their old houses, so that the line is now likely to be kept open. From a distance of about twelve miles below the town of Maingthat, as far as Ta Ton, the Namkôk runs in a narrow channel between hills, and the stream is rendered quite unnavigable by constant rapids, of which the chief is Kyeng Haö Wyen. This is the point at which the Siamese claim that their frontier crosses the Namkôk.

Phya Pap, the celebrated rebel against Chiengmai, was the immediate cause of the destruction of the Viang-Ké group of villages. After the failure of his projected rising at Chiengmai, he proceeded to Kyangton, where, attracting to himself some of the floating bad characters who are scattered about the Shan State, he marched south, and occupied Meung Fang. The Chief of Meung Fang was himself engaged on a questionable enterprise against a State whose destiny, whether to be under our protection or that of Siam, had not been decided; but he quickly returned to his capital, and, driving out Phya Pap, pursued him across the Meh Kok, and, on the ground that the Shan villages on the north bank had given assistance to the rebels, burnt them; hence the general devastation. The mission was running short of supplies, so I, with a large detachment of mules, went off to Meung Fang to try to get provisions. The Chief was, in consequence of his former conduct, greatly afraid of us, and tried to keep away; but I routed him out, and got him to give orders that rice, chickens, &c., might be sold, for, without his permission, the people did not venture to trade with us. The plain of Meung Fang is a rich possession, and of great extent.

On my return to Viang-Ké, we were further detained by the non-arrival of Mr. Kennedy, who had met with some difficulties with the hill tribes whilst foraging. At length, to the relief of our anxiety, he returned, and we travelled in a north-easterly direction to Ban Meh Chan.

The country, including the site of the old and large town of Viang-Ké, is covered with impassable cane-brake. The number of tigers is, therefore, very great; and, until we left the Namkôk, there were alarms in the mule and bullock camp every night, and sometimes several times in the same night. No mules were taken, but several bullocks were carried off. The density of the jungle secured the safety of the tigers. From Meungngam, the road leads gradually up to a double ridge, the highest of which is 2,750 feet above the sea-level. The ascent and descent are very gradual, and the roads, under ordinary

circumstances, and with regular traffic, would be very easy. It had, however, been almost totally disused for many months, with the result that we marched mostly along stream beds, and by-paths, cleared for us by working parties, through interminable stretches of giant bamboo. At length we entered the western fringe of the great Chieng Sen plain; but, although there were abundant signs of former cultivation, no inhabitants were met with until we reached the Laos villages round about Ban Meh Chan. Just under the hills, at Pung Pen, there is an extensive area of hot springs. There is a considerable deposit of sulphur, and the air was heavy with the smell of sulphuretted hydrogen. The water bubbled out from fissures of a reef of rock, and in at least one place spurted out in a spray to a distance of two feet. We had no apparatus for testing the temperature, but it seemed to be very close on boiling point, and, in the early morning, heavy masses of steam rose from the marsh formed below the springs. A still more singular circumstance was the existence of similar springs of hot water in the bed of the Me Chan, which flows a short distance to the south. The stream is quite deep enough to suggest a bath, and the springs in its bed are quite hot enough to the bare feet to cause the bather to jump.

Our route lay under the abrupt precipitous ridges, which marks the western boundary of Chieng Sen. Kyaington villages have crept down under this range, and are stationed on the upper waters of nearly all the rivers here, as far down as the Mè Sair. Close to the sources of the Mèh Tham, which flows out of a cavern at the foot of a sheer cliff, are two fine caves high up in the face of the precipice; inside both are shrines, pagodas, and images, which seem now-a-days to attract few worshippers.

At Honglük we were again in the Shan country; the plain which we had been traversing formed the principal point of inquiry for the Commission, and from the want of any strong natural feature it will be hard to define the boundary.

As I wanted to enter Tonquin through the Siboong Pana, a route which no European had hitherto travelled, I with great regret bid farewell to my friends of the Commission to go on alone. This was by no means agreeable to my mulemen, who were afraid of going into a new country. However, extra pay tempted them, and I left on February 1st.

On the way to Chieng Lap, we passed by Meung Len, 21½ miles distant from Honglük, on the north side of the stream named after it, and in the centre of a very fine plain. It was the largest and most flourishing place I had seen in the Shan States.

There are some fine brick monasteries, and I saw a man smelting and working silver, amid the houses that form the apology for a street, a woman working primitive bellows, made of two bamboos, and a feathered piston. The Nam Zen is just fordable, and no more, at this time of the year, when it is at its lowest.

It was a little below Chieng Lap that Garnier, in ascending the Mekong, had to forsake his boats and contiuue his journey by land along the right bank. Even here, some 1,500 miles from its mouth, the Mekong is a noble river. The natural bed would be about 600 yards wide, but where I crossed it was not more than 80 to 100 yards, very deep, and flowing between jagged rocks that protruded out of the sandy channel. A raft was fashioned out of two canoes and a bamboo platform to ferry over me and my belongings. This was not done, however, before some tapers had been burnt to propitiate the devils, and a sacrifice of rice, nuts, and a rupee offered up on the rocks. I was unaware of the ceremony till it was too late to see it. The eastern or left bank of the river is Chieng Kheng territory. We had to descend it for some six miles, marching over the burning sands of the broad river-bed.

Here the Nam Ma flows in, and during the rains its current is so violent, and the volume of water so great, that the passage of the Mekong by travellers going either east or west has to be made below the mouth of the Nam Ma. On a high bank in the angle, formed by the bend of the Mekong, is the site of the ancient city of Viang Kôk. As usual, no sort of idea could be obtained when this city ceased to exist. The ramp and the moat could still be traced, though choked with jungle; and the place must have been of considerable size, and commanding, as it does, two reaches from the one front, must have been of some strength. The whole country from here to the neighbourhood of Meung Long is deserted, and the land itself so nearly flat, with only very gentle undulations, that practically the whole area could be brought under cultivation by irrigation from the Nam Ma, the Nam On, and the Nam An. Meung Long lies in a flat valley, or, rather, a strath, along the banks of the Nam Ma. It is the beginning of the long plain, as it might be almost termed, which

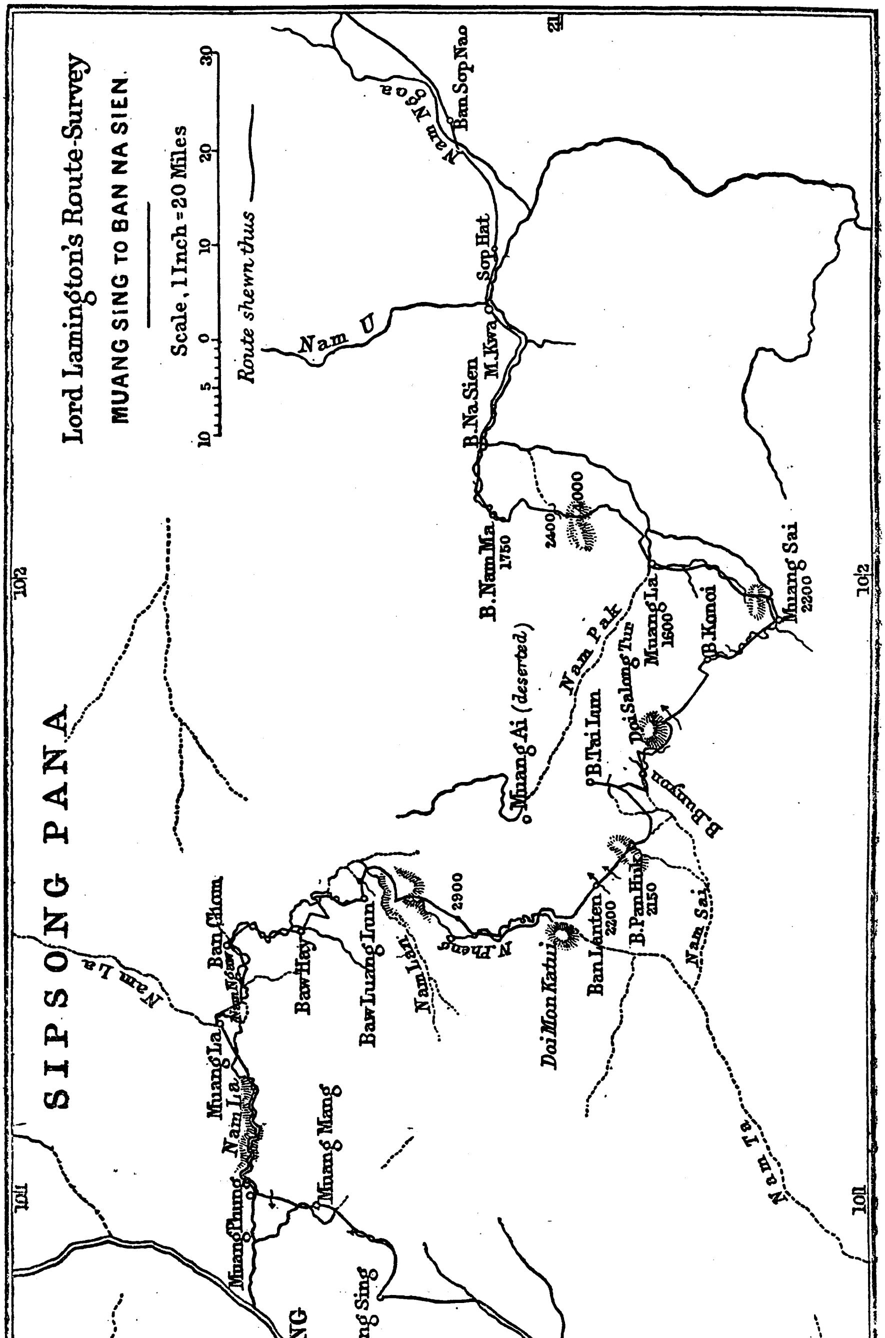
runs up to Meung Sing, and past it, on to Meung Phong, is Chieng Hung territory. It varies in width from a mile or two at Meung Long and Meung Kang, to five or six at Meung Sing, and eight to ten at Meung Phong. Each of these townships is separated from its neighbours by gently sloping ridges from 100 to 200 feet high and covered with dense forest. Otherwise the plain is unbroken, and the existing clearing for paddy cultivation might be enormously extended without any other labour than that of clearing the jungle. To the west a high range growing steadily higher northwards separates the strip of plain land from the Mekong, and to the east hills tower up to heights of 6,000 or 7,000 feet, shutting off the Siamese territory so completely that there is absolutely no regular communication except perhaps toilsome tracks from one village to the other. The gradual resettlement of the Trans-Mekong country drew the chief town eastward to the ancient town of Kyang Kheng on the left bank of the river, and from there the present Chief on his accession moved further eastwards to Meung Sing, no doubt as a precautionary measure against possible attacks from Kyangton. Chieng Kheing is by rights tributary to Kyangton, but the Sawbwa of the former was offended that his nephew should have been made chief of the latter State, and at our recognition of his nephew's claims. In his anger he had placed himself under the protection of the Siamese State of Nan. As Kyangton was one of our protected Shan States, I could not be sure what reception the Sawbwa of Chieng Kheng might give me, no European having ever visited the place. I, therefore, advanced with caution, and sent on my two interpreters to ask for camping ground: my whole party only numbered eight persons. Everything passed off satisfactorily, and I paid a visit to the Chief, a kind, portly old gentleman, and most anxious now to return to his proper allegiance.

Except rice, coffee, opium, and a small amount of tea, which is more cultivated as one goes north, till the tea-gardens of Ibang are reached, there is no produce of any value in the State, sugar-cane and tobacco being only grown for personal consumption. This, however, is only because the land has not its resources developed, and requires better means of communication. Otherwise it is decidedly fertile, and, I should say, has a larger population than exists in adjoining regions. In my opinion, it is highly important that our Government should not shrink from accepting the allegiance of this State. The responsibility is insignificant compared with what they incurred when they took on Kyangton, the capital of which, under favourable circumstances, is a month's march from their nearest military post. At present, the frontier rests on the Mekong; and a river is always an undesirable frontier, more especially in this case, when, by crossing over, there is a mountain range, with no path fit for even pack animals from between Meung Sai, in the south, till north of the parallel of Chieng Hung. This would form an excellent line of demarcation between us and the French, and no one with any knowledge of that country would deny that the day must come when we and the French have conterminous frontiers, for they will advance till they meet us. Moreover, we should, from our position, be giving moral support to that portion of Nan lying on the east bank of the Mekong, and we should ourselves be holding a commanding position in the fertile districts of the upper part of that river. The Government, by accepting what is offered them, would acquire what I consider to be of utmost value to our interests.

I left Meung Phong, one of the towns of the Sibong Pana, held to be the richest and most fertile region in northern Indo-China, thence on to Meung La, where, finding a due easterly course to the Black river was impossible, I had unwillingly to go south-easterly to Meung Sai. The difficulty of obtaining information was very wearying. Descriptions of the route were never reliable for more than two days' journey ahead at the most, and drawing maps on the ground was the only method at getting an idea of the relative distances between places.

We were disturbed on one or two nights by dacoits taking our mules. We were, however, always successful in retrieving them. The people generally were most friendly, and extremely interested in all my possessions. When it happened that I camped near a village, the whole population turned out to gaze in wonderment at my eating with a knife and fork. The hill tribes, of whom there are many varieties, are timorous. They live hardy lives, wandering about as the soil on the hill sides becomes exhausted by the crops of paddy.

I passed the salt wells of Baw Hay and Bawlun. This salt forms an important article of commerce, and the Panthay caravans load up with it on their return westward journey. The village chief endeavoured to prevent my visit-


Lord Lamington's Route-Survey
MUANG SING TO BAN NA SIEN.
Scale, 1 Inch = 20 Miles
10 5 0 10 20 30
Route shewn thus
SIPSONG PANA
CHIENG KHENG
Me Kong River
Nam Ma
Chieng Lap
Muang Sing
Muang Mang
Muang Phung
Muang La
Nam La
Ban Chom
Baw Hay
Baw Luang Lun
Nam Lun
N. Pheng
2900
Doi Mon Katui
Ban Lanten
2200
B. Pan Hin
2150
Nam Sai
Nam Ta
B. Buyon
B. Tai Lun
Doi Salang Tur
Muang Ai (deserted)
Nam Pak
Muang La
1600
B. Konoi
Muang Sai
2200
B. Nam Ma
1750
2400
5000
B. Na Sien
M. Kwa
Nam U
Sop Hat
Nam Ngoa
Ban Sop Nao
101
102
21

ing the wells, being afraid that the presiding spirit would be annoyed at seeing a stranger. They themselves never venture near in either black or white clothes.

Here the hill tribes are mostly Yao Yin. They have the neatest and most intelligent appearance of all the hill people, and bear a closer resemblance to the Yunnanese. The women have a light complexion, and wear a loose kind of Turkish trousers of very finely embroidered silk, a long loose coat, and numerous silver ornaments. On ceremonial occasions, they wear an extraordinary head-dress of red cloth stretched over a stand about six inches above the head, and about two feet long and one broad.

A monotonous thumping sound attracted my attention to a novel rice-pounding machine in use about here. Water is led through bamboo pipes into a hollow cut into one end of the rice-pounding pestle, which I had hitherto always seen worked by foot, the pestle then rises with the weight of water at the other end, the water is automatically discharged, and the pestle falls back and pounds the unhusked paddy.

At Meung Sai I was in Luang Prabang, or Siamese territory; thence the hard travelling began. Pack animals never go beyond Meung La. I had to take a path along the crest of the hills on the left bank of the Nam Pak. Some of the ascents were, I feared, impossible for loaded animals, and the narrowest of tracks on precipitous slopes, often blocked by fallen timber, made our progress slow, though I had several natives cutting a way. When we again reached the Nam Pak, I put the luggage on rafts and allowed the mules to scramble along the banks as best they could. My mulemen were now complaining of the hardships of the road till on March 4th we reached the westernmost French port, called Dien Bien Phu. It was pleasant to see once again a European, of whom there were three here, and a half company of Annamite troops. The road now to Lai Chau on the Black River had some pretence to the title of a road, our only mishap being an onslaught of tigers on our mules. The country was very unhealthy, and though the soil of the plains is undoubtedly fertile, the villages look poor. But then, till recent times, the country has always been terribly devastated by warfare. The Black River is well named, as it flows through deep gorges. Lai Chau, though marked with big letters, is only of importance as a military post, the native houses numbering some half-dozen. Here I left my retinue and mules, except a faithful Chinese interpreter. My voyage was now in a long, uncomfortable, narrow boat, and the three or four days I spent in reaching Chobo would have been most monotonous except for the excitement of shooting the rapids.

Some six weeks previous to my arrival dacoits had attacked Chobo, three Frenchmen had been killed, and the place burnt; the marks of bloodshed were yet visible. It was now re-occupied by the French; but I had to take an escort for my further journey. At Tuvu, opposite to the curious rocks on the right bank, called—from their resemblance to the church—Les Rochers de Notre Dame, great excitement prevailed, owing to a large force of troops having just returned from a three days' successful encounter with the dacoits, or "pirates," as styled by the French. The pirates had crossed the river, and had been heard firing on the opposite side. The hills now receded from the river, and in every direction over the flat valley fires and smoke came from the burning of the villages, or were signals by the pirates.

I re-embarked, and had a sail hoisted on the sampan, the ropes of which were merely the bark of some creeper or liane. We moored for the night at a military post, called Les Mines de Cuvie; but warned by two sampans bringing up ammunition that pirates were about, we anchored in the middle, and passed an undisturbed night.

After passing the *massif* of Mount Bavi on the right, the delta of Tonquin may be said to commence. Chinese pagodas, and occasionally brick buildings, were visible amid the numerous villages. The junction of the Black and Red rivers is a very tame piece of scenery. The banks are low, flat, and treeless, and the water thick, and but with little current.

Vietri is a large military post where the great Clear River joins the Red River. Here again was bustle and excitement, as a large body of troops were starting to-morrow in search of some more marauders.

I continued my slow and monotonous journey in the sampan, with the boatmen very cross at having to go on during the night, and the Annamite sergeant and myself having to spend the night in urging them on. Enlivened by one or two false alarms of pirates, we reached Hanoi, the capital of Tonquin, and there was a charm, though a sense of awkwardness, in approaching again a place boasting anything of Western civilisation.

At Hanoi I may be said to have finished my journey. The town has no great interest to a traveller; its development has been entirely owing to the large official population of Frenchmen, and these are making it attractive, but its situation in the centre of the delta does not permit of its ever being very charming. A daily steamer took me to Kaiphong, which is the port and seat of commerce of Tonquin.

There are fine warehouses, but nothing in them. The Chinese have left the place. Piracy flourishes within a mile or two of the town, and prevents the natives, through fear, from cultivating the soil. Undoubtedly, however, the delta is rich in soil and in minerals. There is a seam of coal a little way to the north, at Hongay, 169 feet thick. Unfortunately the French home policy has retarded the development of the country.

I visited, in a coasting steamer, the different magnificent harbours on the Annam coast. Rolling green hills, that look as if they would afford excellent pasturage, embosom fertile valleys. The coast, like the delta, is healthy, a contrast to the fever-stricken mountains of the interior. I landed at the charming town of Saigon, having everywhere met with the greatest kindness from the French in their new possession.

It is to be regretted that the French at home don't give a free hand to those in Tonquin to develop the country, in place of trying to keep it as a close market for their own goods. Cochin China was prosperous because of free trade, now it suffers from that advantage being taken away. Tonquin has never had the chance, and with the slow influx of capital, the resources of the delta remain as they were before the arrival of the French. Every kind of restriction is placed on the introduction of foreign capital, to the detriment of the country; whilst the Government monopoly of opium-growing, and the heavy taxes levied on the people, combine to drive them to piracy. It must be said that the French in the possession would gladly see all this altered; the fault rests on the selfishness of those at home.

DISCUSSION.

Sir STEUART BAYLEY, K.C.S.I., said every one present must have been highly gratified at this very interesting paper, giving an account of such a long and adventurous journey, which was so fully illustrated by beautiful photographs. Possibly the most interesting part of the paper to many, and that on which there would be most room for difference of opinion, was that which dealt with the frontier question—as to making the Mekong our boundary, or going beyond it—but that was one which could not be discussed in that Society. He would only remind the Society that the rights and interests of Siam had to be considered. Quite apart from political questions, there were many other points connected with the country on which he was sure those present would be glad to get any further information from those experts who were present, the principal one being, perhaps, the question of trade routes. Lord Lamington had told them, as appeared obvious from the map, that trade from Tonquin could not be expected to go by the Black River to Chiengmai, in competition with the easier routes he had named; but there were many other trade questions, which would be of interest to everybody. Not long ago the proposal for a railway, which was to run through Siam to Yunnan, from the Gulf of Siam, was brought forward, and a proposition was made which reminded one of the description of charity, in which A and B met together, and decided that C should be relieved at the expense of D. In this case the projectors and chambers of commerce decided that the trade between China and this country would be relieved by having a railway to Yunnan, the guarantee for which should be given by the Indian taxpayer, but the Indian Government did not see it in that light, and seemed to consider that if the money of Indian taxpayers was to be spent on a railway, it would be better to have it in a country over which they had some control. The question was still very much interesting the public what would be the best line of railway through this country, but whatever line was taken it must in some way strike the Northern Shan States. One of the difficulties attending the study of Siamese geography was the extraordinary difference in the spelling of names. At one time Chiengmai used to be Zimme. In the south the former syllable was spelt Chieng, but in other maps made by Indian surveyors it was Kieng. Probably it was owing to a difference of pronunciation, the Siamese pronouncing it soft and the Shan States hard. Similarly with regard to the river systems, those in the south of Siam seemed to be called Me, as Me-Kong, but higher up they seemed to be called Nan. He hoped someone with personal knowledge of Siam would throw light on these points.

Sir CHARLES CROSTHWAITE, K.C.S.I., had also listened with very great interest to Lord Lamington's paper. It was very gratifying to those who had to deal with these questions on the spot, from an official point of view, to find men in Lord Lamington's position coming out and visiting these countries, and giving their views on them from an entirely independent standpoint. He hoped many others would follow his example, and visit the great countries of Burma and the Shan States which had fallen under our administration. The question of boundaries must be left to those who

were responsible for dealing with it; but there was nothing of an unpleasant or hostile nature at present arising, nor need there be. It was natural, when we were occupied in annexing Upper Burma, that there should be some little disturbance on the frontiers of the old Burma Empire, and that encroachments should take place, which would now be settled in an amicable spirit. It was a matter of comparatively little importance whether these countries fell under our power or under the friendly power of Siam. The real question was who was to get the trade with them, and how we could make the most of them so as to find fresh markets for our goods, and also employment for those superflous articles of the present day, our boys. This was a question of a great deal of importance, on which a great deal had been written. Everybody who had looked into it knew the route so ably advocated by Mr. Colquhoun and Mr. Holt-Hallett for making a railway from Maulmain, up the valley of the Salween, and through Siamese territory to the Shan States, a line which they hoped to connect with another railway coming from Bangkok. Although at present the question of the route was still open, and could not be decided, because sufficient information had not yet been obtained, he ventured to think the true course would be for us to remain, as far as possible, within our own territories, and, therefore, to start off from a point on the Mandalay Railway, and take a course up to the north-east and through the Shan States, and in that way touch the border of Yunnan; from thence, perhaps, deseending again, and dealing with the countries through which Lord Lamington had passed. At present the surveys were incomplete. He hoped that those interested in the trade of England would keep public attention to this point. We had annexed the country of Burma, which of itself was of great value, but its real importance lay in the fact that it might become the high road of our trade with China, and by that means, with a port like Rangoon and a railway running up to the Chinese frontier, we could get command of a new field for English commerce. If those who had the leisure, opportunity, and power of effecting such enterprises would go into these countries, and bring their influence to bear on questions of this kind, much good would be done.

The CHAIRMAN then invited Mr. Ridley, the engineer of the chief line from Bangkok to Chieng-mai, and on the Chinese frontier, to give the results of his observation.

Mr. RIDLEY said his stay in Siam was of very short duration, and, owing to the dryness of the season the steamer by which he travelled stuck in the river, and he was not able to learn very much. Altogether, there were eighteen engineers engaged on projecting the various railways shown on the map, which were intended to go up towards Luang-Prabang, but for some reason the Siamese Government had abandoned part of it. Possibly one or two of those gentlemen might be present, and if so, would be able to give more information than he could. The total length of the line from Bangkok to Chieng-sen was about 620 miles, from Sarraburrie to Khorat about 95 miles, and from Bangkok to Khorat 145 miles. The highest summit which had to be passed was just beyond Zimme, and the level of the line there would be 3,173 feet above sea level. The height of the range was much higher than that, and the railway, when made, would have to go through a tunnel about half the length of the Mont Cenis, or nearly four and a half miles. The whole of the time the engineers were there, the reports they sent home fully confirmed what had been said in the paper as to the very peaceable disposition and amiability of the Siamese. At first they were rather shy, but after a short time they found that the engineers were honestly engaged, not intending to rob them, and they had no trouble whatever. The natives used to come into the camp and bring them supplies with great readiness. His own impression was, that if the projected line were made, it would be very important to connect it with Maulmain and British Burma, but it was not easy to design a railway across a country like this, where the jungle was so dense, and, in some places, grew from 15 to 25 feet high, so that an engineer found it very difficult to select a route. A short time ago the Siamese Government had made a contract for the construction of part of the main line from Bangkok to Aynthia, and for the branch line to Khorat, and the first sod would probably be cut in the course of a few months.

General MICHAEL, C.S.I., said:—I have really very little to say beyond expressing pleasure at hearing the very interesting paper which Lord Lamington has read. I should not have ventured to speak at all but for one sentence in it, which appeals directly to my feelings as an old forest officer. It is this, "We saw a certain amount of teak, but this, wherever it can be worked to a profit, is fast disappearing before the axe of the Burmese forester, and there are no attempts at replanting." I know too well what this means. Cruel waste and rapid destruction of old and young trees indiscriminately. Lord Lamington's graphic description of his river journey recalls vividly to my recollection an expedition which I made, more than 40 years ago, up one of the southern Burmese rivers, shortly before the war of 1851, which gave us Rangoon and British Burma. I then saw the waste and destruction caused by the uncontrolled Burmese forester. I had been sent by the Madras Government to see whether I could pick up hints from the Burmese system of working which might be turned to good account in the experimental conservancy work on which I was then engaged in the Anamully hills. If England or the Government of India are in a

position to offer advice to Siam, the importance of preserving their forests should be advocated. The Siamese have an example close at hand, in the effects of good forest administration in British Burma and throughout India.

The CHAIRMAN, in proposing a vote of thanks to Lord Lamington, said he should like to refer to what had fallen from General Michael, who said he hoped that the question of re-foresting the lands of Siam would be brought forward, and that British officers should influence that country in the direction of re-foresting. It was a great satisfaction to him to be able to say that the enlightened ruler of Siam was establishing a forest department for the very purpose of doing what General Michael suggested. He felt a strong personal interest in Siam and its government, and without touching on any political questions, he must say he was very glad to see this young English statesman so alive to the obligations and responsibilities which, more than half a century ago, England took upon herself with regard to this kingdom of Siam. After Bowring's treaty with Siam, we had been in constant communication on both political and trading matters with the various rulers of the country, and whilst we had reaped considerable advantages from that treaty, we had not in any way paid for it by any obligations or anxieties of our own. If the question of boundary was to be settled by France and ourselves, he trusted the obligation and duty we owed to Siam would not be lost sight of. In 1875, when conducting negotiations in Siam, he was assured by the then representative of France, and subsequently by a dispatch from the French Government, that French influence did not extend in the direction in which it was now going, and that her area of intervention was entirely confined to the south-east and Lake Cambodia; and, therefore, whilst certain subjects with reference to authority in the Shan States were raised, at that time France had in no way interfered. The present ruler of Siam, during the 20 years that he had been on the throne, had acted in such a way as to demand the sympathy and support of Englishmen. He was the first to declare that slavery should cease out of his land; and every opportunity had been taken, and every effort made, considering the enormous difficulties he had to deal with, to stamp it out throughout his dominions. With reference to the occupation of the land, and the way in which it was held, he had studied our Indian system, and instead of the oppression under which the lands were held at that time, had introduced a system by which the ryot and the farmer could enjoy a fair amount of his toil. His object, as he himself told him in 1875, was to have a free people on a free soil. When he ascended the throne, posts of communication and post-offices were unknown; but these were powerful influences in developing enlightenment and civilisation, and they were now fairly distributed. He had also introduced the telegraph, to bring the various centres in connection with the capital. He had also done much with reference to the sanitation of the towns, although there was a good deal yet to be done; and also with reference to various old customs; the chiefs having armies and retainers of their own he had swept away, and there was but one army and one revenue. At times, every chief took toll, and even in Bangkok, in 1875, there were taxes for the first king and taxes for the second king, and for various high officials. All that was swept away, and with it the corruption and oppression under the old system. He had done much to purify the courts of justice, and make them worthy of respect, and all this in the face of enormous difficulties, one of the greatest being that arising from the very treaty obligations he had with this country with regard to the consular powers. He hoped, when the time came, there would be sufficient public opinion in this country to justify a change being made which would restore Siam to the independence she had lost by those treaties. He hoped that when the settlement of the boundary took place care would be taken that not one single acre of territory to which Siam was justly entitled should be sacrificed for any political reason, and that we should do all we could to create an independent Siam, and offer to it and its Government our most hearty support and sympathy. If this were done, he believed it would be of enormous value to the best interests of England.

The vote of thanks having been carried unanimously,

Lord LAMINGTON, in reply, said undoubtedly the King of Siam was doing an immense amount of good work for his country, and was trying to bring it more and more into a liue with the ordinary ideas of Western civilisation. Of course, he had great difficulties to cope with; first of all, whilst at Bangkok and the surrounding districts he was able to exert absolute authority, owing to the want of communication, it was very difficult indeed for him to enforce those regulations in the more distant parts of the country. That was one reason why it was so desirable that Siam should have communications opened up by means of railways. From what he saw of the country, he believed that a railway would eventually pay. It was true there was a great want of population, but a railway would create population. It created wants, and led to the land being brought under cultivation, and when that was done towns would spring up. From Bangkok to Chieng-Mai it was now a three weeks' journey for passengers; for goods it took about five weeks, the distance being about 500 miles, yet Chieng-Mai was a very flourishing place with a good market and a certain amount of wealth, and if there were a railway the journey could be done in 24 hours. The difference in cost of a ton of goods in Bangkok and Chieng-Mai was something enormous. The railway would certainly be made some day, and it might also be desirable for British interests to have a separate railway in British terri-

tory, but there was ample room for both, and he believed that each would help the other. Rivalry in trade produced trade. Some people had an idea that when one country got good trade the adjoining country suffered, but he did not believe in that notion at all, and although we might have our own line from Burma into the Shan States, he hoped the King of Siam would have another running to Chieng-mai, eventually perhaps joining our line at Chieng-sen. With regard to the difficulty about spelling names, every person who made a map spelt the name differently. A European in Siam would spell a name as the Siamese pronounced it, another in Laos would spell it as it was pronounced there, and some-one in Burma would write the name in a different way, there being slight differences of pronunciation in each case. The particular instance of Chieng-mai being called Zimme arose arose from the Burmese being incapable of pronouncing the word Chieng-mai, and he had even seen a map made by Indian surveyors in which Chieng-mai was put in one place, and Zimme a few miles off. With regard to the frontiers, there was room for all parties in Indo-China, and he thought the English and Siamese Governments deserved great praise for putting the frontiers in order. There only remained a very small portion which was practically still unsettled. Otherwise the whole boundaries were agreed upon. He was perfectly well all the time he was travelling, but had an attack of fever after he returned home. It appeared to be generally the case that Europeans whilst employed in the jungle were perfectly well, but when they got back either to their temporary home or to this country fever was certain to develop.

Mr. Holt S. Hallett commuicated the following remarks on Lord Lamington's paper:—The information obtained by Lord Lamington during his journeys in Indo-China should prove of intense interest to our commercial and mercantile communities, and should be closely studied, weighed, and considered by the officials in charge of our foreign and Indian affairs. Such action is all the more advisable and necessary in face of the lamentable political fiasco that has recently occurred, much to the indignation and vexation of our merchants and manufacturers on the West Coast of Africa, where a vast and rapidly increasing British market has been snatched from us, and finally annexed by the French. Matters promise to follow exactly the same course in Indo-China, and with no excuse for the astonishing ignorance and apathy displayed by those controlling our foreign and Indian affairs. By the treaty of 1769 with the King of Burma, it was stipulated that the King of Burma "should re-open the golden road to China." This proves how much attention was paid to the subject of increasing our trade relations with China, even at that early date. In 1795, a British envoy was sent to Burma, with the same object in view. Since our acquisition of the Burmese coast provinces of Arakan and Tenasserim, in 1826, our merchants have been vigorously improving their trade relations with Indo-China, and looking eagerly forward to the time when the means of interior communication would be so far improved as to enable them to lay down our merchandise, not only in Indo-China but in South-Western China at a price which would ensure us millions of customers, who, without cheapened means of communication, were precluded, by their comparative poverty and the great cost of carriage, from becoming extensive purchasers of our goods. Even with the present cost of carriage we have so expanded our trade that thousands of our fellow subjects have for many years been employed throughout Siam and its protected States conveying our goods, and the great market covered by the Siamese dominions is practically, and nearly exclusively, a British market. To understand the threatened action of the French in the half of the Siamese dominions that lies in the valley of the Mekong, we must remember that the policy of creating a great eastern empire for France, that was to fully compensate for the loss of their Indian Empire, was fully set forth by Admiral de la Grandiere, the first Governor of French Cochin China, after the annexation of three provinces from Annam in 1862. As this policy has been consistently carried out step by step, as occasion and means allowed, by the French ever since it was first set forth, and as its continuance has been urged and openly avowed by every French official that has set foot in Cochin-China, it will be well to look it plainly in the face, and consider how far it conflicts with British interests in China and Indo-China. Admiral de la Grandiere's policy was the annexation of the whole of the Annamite dominions (including Cochin-China, Annam, and Tonquin), Cambodia, the Siamese provinces and protected states in the basin of the Mekong, the Burmese Shan States in the basin of the same river, and the southern provinces of China, as opportunity arose through the frequent insurrections in that part of the Chinese Empire. All of these places formed extensive, and nearly exclusive markets for British, British Indian, and British colonial goods, and all of these markets, in which French goods hardly made an appearance, would be closed to all but French manufactures as soon as they had passed into French hands. Since 1862, the French have so far carried out the admiral's policy as to incorporate Cochin-China, Annam, Tonquin, and Cambodia in their dominions, and have for many years been employing officials, in the guise of scientific travellers, to spy out the Burmese and Siamese possessions in the valley of the Mekong, with the view of eventually incorporating them in French Indo-China. China has, as yet, proved too hard a nut for them to crack; and the annexation of Tonquin has proved a costly and not very satisfactory affair. French attention is now evidently turned to the Burmese and Siamese possessions in the basin of the Mekong. That early action may be expected is evident from M. Ribot, the French Foreign Minister's

speech last October, and from the appointment of M. Pavie, late French Consul at Luang-Prabang, as Consul-General at Bangkok, and M. Lanessan, as Governor-General of French Indo-China. If we allow the portions of the Burmese Shan States of Kiang Hung and Kiang Tung, which lie the east of the Mekong, to fall into the hands of the French, by not asserting our supremacy over them, we block the best route for railway connection between Burma, Siam, and China, and enable our French rivals from Tonquin to replace our goods in south-western China and Shan States by French manufactures. The "Sibsong Pana," which, according to Lord Lamington, is "held to be the richest and most fertile region in Northern Indo-China," implies "twelve provinces," and is applied by the Shans to the twelve provinces of Kiang Hung, three of which lie to the west of the Mekong, and nine to the east of that river. I need hardly draw attention to the recent acts of war perpetrated by Siam upon the territory of our vassals, during which they have annexed districts of our protected State of Kiang Tung (Kyaington), namely Muang Fang, Muang Ngam (Meungnyam), Kiang Hven, and Kiang Kheng (Chieng Kheing), and destroyed the Viang Ké group of villages. By allowing the Siamese to keep these provinces of Kiang Tung, and preventing the chief of that State, who is now our vassal, from reconquering them from Siam, we are not only wronging him, but are allowing the Siamese to keep territory which, in their hands, may any day be lost to us as a market by being annexed by the French. The Siamese should be forced to retire from these provinces of Kiang Tung, which they could not have conquered or kept had it not been for the rebellions recently raging in the Burmese Shan States, and the consequent disturbed and weakened condition of the Shans. Even though some of these annexations like that of Kiang Hsen and Muang Fang occurred as early as 1881, these provinces of Kiang Tung were merely held by force, and no peace had been signed by the Chief of Kiang Tung giving up his claims to them. He still claims them, they are his by right, they form part and parcel of the Burmese dominions, and Siam has no right whatever to them. The policy of annexing the territory of its neighbours is an insane one for Siam to pursue. It sets a very bad example to the French, which they will doubtless be only too glad to follow at the expense of Siam.

The blocks of plans illustrating Lord Lamington's route have been kindly lent by the Royal Geographical Society.

FOREIGN AND COLONIAL SECTION.

February 16, 1892; The Hon. JOHN X. MERRIMAN, M.L.A., in the chair.

The paper read was "The Forthcoming Exhibition at Kimberley," by LEWIS ATKINSON. The paper and report of the discussion will be printed in the next number of the *Journal*.

TENTH ORDINARY MEETING.

Wednesday, February 17, 1892; General Sir GEORGE CHESNEY, K.C.B., C.S.I., C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Ellis, Walter L. J., 30, St. John's-wood-road, N.W.
Herschel, Alexander Stewart, M.A., D.C.L., F.R.S., F.R.A.S., Observatory-house, Slough, Bucks.
Parsons, Hon. Richard Clere, Oak Lea, Wimbledon-park, Surrey.
Sturge, Edward Brockway, 20, The Waldrons, Croydon, Surrey.
Wollaston, Arthur N., C.I.E., India-office, S.W., and Glen-hill, Walmer, Kent.

The following candidates were balloted for and duly elected members of the Society:—

Goodman, Prof. John, The Yorkshire College, Leeds.
Handcock, Henry W., Lanorna, Blyth-road, Bromley, Kent.

The paper read was—

THE PAMIRS AND NEIGHBOURING REGIONS.

By CAPTAIN F. E. YOUNGHUSBAND, C.I.E.

Looking from the plains of Northern India one sees to the north a lofty barrier of snow-capped mountains which enclose the Punjab like a wall. Yet these ranges visible from the plain are only the first of a succession of similar ridges which rise tier upon tier till the main axis of the Himalayan system—the watershed which divides the rivers of India from those of Central Asia, and which roughly forms the boundary of the territories under the influence of the Government of India—is reached.

Up to this point the country is fairly well known, and many writers have told how, passing over the first range from the plains, the lovely vale of Kashmir is reached, from which again rise forest-clad mountains with snowy summits; and how, on the other side of these, the traveller finds himself among bare sterile mountains almost entirely devoid of vegetation, which, increasing in height as one penetrates inland, finally culminate in peaks of 25,000, 26,000, and even 28,000 feet in height. So far our knowledge of the country is considerable, though even here there is much

to learn, especially about the vast seas of ice with which the valleys near the highest range are filled. But beyond that point we are yet very ignorant. Light, however, is gradually being thrown upon it, and now I would add one more ray to those which have been sent forth by the bold and hardy travellers who have preceded me in the gradual exploration of the unknown.

The portion of the mountain barrier on the northern frontier of India which I wish now more particularly to describe is that round the meeting point of the Hindu Kush and Karakoram or Mustagh ranges—the apex of Central Asia as it were, where waters divide north and south, and east and west, and which, too, is the cradle of the Aryan race, and the spot whence sprung many of the chief languages of the globe. To the north of this is the region of the Pamirs, the Bam-i-dunya—the Roof of the World—round which the three great empires of India, China, and Russia touch each other. Intensely interesting this region is to study, to talk over, and to read about, and yet the traveller who visits the spot sees little to arouse enthusiasm in him. In place of the great, lofty peaks which he would have seen on his way thither, from whichever side he approached the Roof of the World, whether from the east by the Tagarma peaks (25,000 feet high), or from the west by the lofty mountain summits overhanging Shighnan, or from the south by the great peaks—nearly 26,000 feet—round Gilgit and Hunza, or from the north by Peak Kaufmann (22,000 feet); in place of these, when one comes to the Pamirs proper, one sees mountains rising for a very few thousand feet above the valley bottoms, and often, especially at the eastern end of the Great and Alichur Pamirs, the mountains have dwindled down to mere low, rounded hills. Nor are the valleys more striking than the mountains. They are not fine gorges hemmed in by lofty, precipitous cliffs like one sees in Hunza, but open, level plains, four or five miles in width, bounded by gentle gravel slopes leading up to the mountain summits. They are not finely wooded and picturesque like those in Kashmir and Ferghana, but are entirely devoid of trees and even shrubs. And, lastly, they are not richly cultivated or dotted with thriving hamlets and villages as one sees in parts of the Himalayas, but for the most part covered with coarse scrub, with patches of good grass at intervals only, and inhabited by pastoral nomadic people living in tents.

The region of the Pamirs, in fact, consists of a succession of long broad open valleys, running approximately parallel to each other in a general direction from north-east to south-west, and separated by low ranges of mountains, rising, as I have said, to no considerable height above the valley bottoms.

The climate of this inhospitable country is one of great severity. The very lowest point of the Pamirs is 10,300 feet above sea-level, and their usual average is from 13,000 to 14,000 feet, and naturally the cold at such great altitudes must be intense. Of the winter I have had no experience, and can only judge of what it must be from what I have felt in the late autumn, at the end of October and the beginning of November, when I have seen the thermometer 18° below zero (50° of frost). The Kirghiz tell me that the snow then usually lies about knee-deep, but seldom more than that. They remain on these high valleys all through the winter, while their flocks and herds find what they can to eat, grubbing amongst the snow. Spring hardly occurs at all. The hardy French traveller, Bonvalot, and his companions, crossing the region in March, suffered most intensely from the cold; and Colonel Gordon and the members of the Forsyth Mission, who visited it in April and May, found the country still very wintry in appearance. By the end of May, however, the snow seems to melt, and soon after summer may be said to commence, though even during that season the nights are still very chilly. The earliest date on which I have been on the Pamirs is the beginning of August, and then the water in the basin of my tent was frozen at night. Snowfalls occurred by the end of that month, and at the end of September the thermometer had reached as low as zero, Fahr.

But though the climate is severe now, it must at one time have been still more so, for one sees constantly on them and especially on the Alichur Pamir, signs of glaciers even in the valley bottoms. At the present time there are no regular glaciers, or rather only very small ones near the higher peaks. But formerly I should almost imagine the Pamir valleys to have been filled up with seas of ice, and the impression which one is given on looking at the hills and valleys of this region is that the mountains must have formerly been of a considerably greater height than they are at present, and that in course of time they have crumbled up, decomposed, and, as it were, melted away, their remains falling into the valleys and choking and gradually filling

them up; while the climate was too severe for there to be a sufficient rainfall to wash this *débris* away. Even now, if the climate were to become milder, and the rainfall consequently greater, the Pamirs would exist no longer, but be scoured out into deep valleys, such as exist all round this elevated region. For one remarks in every instance of a Pamir that at its lower extremity where the climate becomes milder, the summer longer, and rain more frequent, the gravel of the broad level Pamir valley is wasted away, and the river runs off through deep gorges. The Great and Little Pamirs, for instance, end up in the deep-set valley of Wakhan, the Alichur Pamir in the defiles of Shighnan, and the Tagh-dum-bash Pamir among the narrow passages of Sarikol.

A point, too, which ought to be noticed about the mountain systems of the Pamir region is, that the watershed of the range connecting the mountain systems of the Himalaya and the Hindu-kush with the Tian-shan is not the main axis. The watershed across the Pamirs, which divides the river systems of eastern and western Asia, is a comparatively insignificant range, with peaks probably not more than about 20,000 feet high, and few even of that height. But east of these is the great wall of mountains which overhangs the plains of Kashgar, with peaks over 25,000 feet in height, a bold, clearly-defined line of mountains, which ought certainly to be considered the real axis of the connecting link between the mountain systems of northern and southern Asia. It often occurs, indeed, as in this instance, that the real axis has been cut through by streams running from a water-shed of inferior dimensions lying to one side; and map-makers who mark the watersheds more distinctly, and throw the really higher axes of the mountain system into the shade, often mislead the traveller, who expects to see high ridges where perhaps low ones only exist, and comes across vast mountains, when only low hills were looked for.

The most southerly of the Pamirs is the Tagh-dum-bash, and beyond that the country changes in a remarkable way. I had the good fortune, in 1889, to have the opportunity of exploring a hitherto unknown tract of land, lying between the last-named Pamir and the caravan road which leads from Kashmir to Yarkand. On our maps all the valleys on the south side of the great range of the Karakoram or Mustagh mountains in this part were shown as filled up with vast glaciers, but nothing was known as to the character of the northern slopes of these mountains beyond what I had seen of them when crossing the Mustagh Pass. In 1889, however, I found glaciers on both sides, all the valleys in fact, on the north as well as on the south side of this strip of two hundred miles, being filled up with great seas of ice. The sides of the valleys are steep and precipitous, and the mountain peaks rugged and enormously high, showing the greatest contrast between the Pamir country on the one hand and the undulating gravel plains and rounded mountains in the vicinity of the Karakoram Pass on the other. It struck me, indeed, that the great mass of peaks round Mount Godwin Austen, four of which are 26,000 feet high, and Mount Godwin Austen itself, over 28,000, must attract more than their proper share of the monsoon clouds coming up from India, the snowfall consequently being greater here than in the regions on either hand, and hence this vast accumulation of glaciers which are probably the most wonderful on the face of the earth.

Time does not permit me here to describe them in detail, but I hope that a few general remarks upon these marvellous creations of nature may prove of interest. Ascending the broad pebbly bed of any of the streams which run down from the northern slopes of the Mustagh mountains one sees in front what appear to be great heaps of gravel, from the foot of which issue a stream. On nearer approach, one finds that the heart of these gravel heaps is pure ice, and that this is the extremity of a glacier. Clambering up to the summit of one of these mounds, the traveller looks upward over a sea of needle-like pinnacles of ice, and amongst these sees long lines of rocky *débris*, the medial moraines of the glacier; while on either hand mountains of stupendous height rise in stern and solemn glory. These pinnacles or seracs of ice are of every fantastic shape and variety of colour, sometimes pure opaque white, sometimes dark green, and sometimes a delicate transparent blue. Amongst these may be seen fairy-like caves and grottoes of pure ice, with icicles twenty or thirty feet in length hanging from the ceilings or formed in a delicate fringe across the entrance, and into the walls of these lovely caves one can look as into a sheet of glass. Still ascending the glacier through mile upon mile of this beautiful ice scenery, the seracs become less sharp and distinct, and the moraines disappear, till at length the great snowfields at the head of the glacier are reached. Here all is white, pure and unblemished; and the bold intruder is deeply

and unforgetably impressed with the noble sublimity of the mountains towering round on every hand, and moved by his audacity in daring to intrude into regions ruled by nature in such stern and stately grandeur. He feels, too, what tremendous forces must be so constantly and continuously at work beneath the calm and placid surface; for while at first sight all seems still and unchangeable, a glance around shows the glaciers rent into great chasms with perpendicular walls of ice, perhaps hundreds of feet deep, into which, if a stone is dropped, it bounds from side to side, and the echoes are heard coming up from the very heart of the glacier. And then a little observation shows that these vast seas of ice, motionless and immovable as they seem, are year by year forcing their way down the valleys, carrying on their icy bosoms the fragments and craigs of rock which have been broken off from the mountains by the nipping fingers of the frost. Great cliffs, too, are met with, worn away and ground by the glacier forced against them; and I have seen a whole cliff of limestone polished and smoothed by the glacier almost as well as small fragments of rock are by the hand of man. With evidences of such mighty forces as this before him, the lonely traveller cannot but feel overwhelmed and awed as he looks on this marvellous handiwork of nature, and sympathise with the superstitious hill men who regard these mountains with such reverence and respect.

Many interesting phenomena, too, may be witnessed in these mountains. I have looked on a mountain peak, and then, a few moments later, seen it gradually disappear before my eyes, almost as if it had vanished away; and it was only by a closer observation that I could make out that it had been overshadowed by an imperceptible snowstorm. The snow, indeed, in these mountains was often very fine, and almost like dust; and a very beautiful effect is, that it nearly always falls in perfect little hexagonal flakes, like little stars of lace-work, each one quite distinct, and remaining intact until it reaches the ground; then, as it has fallen, the snow of course remains white on the surface, but, digging into it, it appears of a beautiful delicate pale blue colour. Another effect of the snow is seen at the mountain tops, when the peaks seem to be fading away and vanishing off like clouds of whitened smoke—a beautiful effect, produced by the high wind blowing away the fine dust-iike snow at the summits. Again, another almost similar phenomenon on the mountain tops is that of long, level clouds, like streamers, flowing away from the peaks. The moisture-ladened air from the plains of India has been condensed on the icy mountain summits, and the wind has blown the mist away in a long thin streamer. Yet one other curious effect I have noticed amongst these mountains is that, after a snowfall, the air has been seen to sparkle and glisten, as if filled with glittering particles of snow lit up by sunlight, and yet the sky may be quite clear, and nothing apparently falling; and I was told that it is considered the presage of great cold to come.

Such is a brief description of only a few of the wonders of this region of peaks and glaciers, of snow and ice, and rocks and precipices where, it is needless to say, no inhabitants are to be found, and where few, indeed, even of the hardy hillmen of the Himalayas, have ever penetrated.

Streams issuing from these glaciers run into a river flowing for some distance parallel with the main range, and eventually joining the upper water of the Yarkand river. This river I had first discovered in 1887 when I crossed it on my way to the Mustagh Pass. I then knew neither exactly where it came from, nor where it went to, but in 1889 I followed it up for some distance towards its source, which I found to be amongst the glaciers east of the Mustagh Pass. Having found out whence it came, I was naturally interested in finding out whither it went, and following it down found it to flow, after a course of 150 miles, into the Jarkand river, and it was near the junction of these two rivers, and also at other points along the banks of the latter river, that I found the remains of human habitations, and signs of cultivation. The country, indeed, which is called Raskam by the Kirghiz, was formerly populated until the raids by the Kanjuti robbers of Hunza forced the inhabitants to leave their homes. I am told, too, that in those days merchants used to trade across the mountains into Baltistan and Kashmir, but this has lately been prevented, not only through fear of raiders, but also on account of the accumulation of ice upon the passes. Smelting furnaces, too, and fragments of smelted ore were noticed in the place, and there is little doubt that minerals are to be found in these mountains, but there are no indications or traditions that they are in sufficient quantities to be worthy of much remark.

It is time now that I should say something regarding the peoples who inhabit these mountainous regions beyond our frontier, and tell

you of the hardy Kirghiz of the Pamirs, of those interesting people the Chinese, our friendly neighbours beyond the border, and, lastly, of the bold robber tribe, the Kanjutis, who have played so important a part in the regions I am describing. The Pamirs are scantily populated by various branches of the great nomadic tribe, the Kirghiz, who inhabit nearly all the hill country in the western end of Kashgaria, who formerly peopled the country of Raskam in the valley of the Upper Yarkand river, and who have even penetrated to, and to this day live, in a spot so remote from the original home of their race in the steppes of Turkestan as Shahidula. They are a rough hardy race, not so tall nor so warlike as the tribes on our Pnnjab frontier, but well-built and strong, as they must necessarily be to withstand all the hardships of a winter on the bleak and barren Pamirs. The women especially are very robust in appearance, with ruddy rosy complexions, well set-off by the high white turbans they wear. They are not ornamental according to our ideas of beauty, but they may at least be called useful, for they appear to do all the work about the tent, milking the flocks and herds, making up the cheeses, manufacturing the felts, and doing all the thousand and one little things that are necessary in family life; while their husbands and brothers are, with the exception of the few who tend the flocks, idling their time and doing nothing. The men have indeed little in their character which one can admire. One admires an Afghan for his manliness, his love of fighting, and his patriotism; one even admires the Kanjuti raiders from Hunza for their boldness and enterprise; but the Kirghiz always appeared to me to have singularly little to attract one, for their whole character is too level and mild, having neither any particularly good or unusually bad traits to excite any large amount of interest in one for them.

My first acquaintance with these people—not with the actual inhabitants of the Pamirs, but with their brothers and cousins—was in 1887, in the hill tracts to the north-east of Kashgar. I was then travelling in the simple style in which some people think that explorers always, or, at any rate, should always travel. I had simply an Afghan interpreter and a Turki servant, while one pony carried all our stores and baggage. In this way we three used to ride forty or fifty miles a day, putting up for the night with the Kirghiz in their tents. The first evening of our ride we reached a small encampment where the only accommodation available for me was with four ladies. This rather embarassed me at first, for I am not very old now, and was younger still in those days. But my modesty was relieved when I found that three of the ladies were grandmothers, and the fourth a great-grandmother—their various children and children's children being away with the flocks on the higher summer pasturages. I was most hospitably entertained by them, felts were laid down in the tent for me, milk and curds were brought, and to crown everything, the great-grandmother insisted upon darning up some holes in my socks, which, as I had come all the way from Peking, were not in such good repair as one would usually like to see them. Every night in this way we used to put up with the Kirghiz in their tents. Usually they were hospitable enough, but on one occasion, when we arrived at a considerable encampment of from eighty to a hundred tents, we found them less friendly, and I noticed a dispute going on between my Afghan orderly and a crowd assembled round him. On asking him what the matter was, he told me that they were anxious to delay me, and talked even of robbing and, perhaps, murdering me. He, fortunately, kept his coolness and presence of mind though, asking them what was the use of delaying me, pointing out to them that I was travelling under Chinese protection, and asking them whether, on the whole, it would not be best to pass me on quietly to the next encampment rather than, by turning me back, to run the risk of annoyance from the Chinese. This they eventually saw. The matter ended peaceably, and I proceeded quietly on my way.

With the Kirghiz on the Pamirs, however, I had no such troubles; and on the three occasions on which I have been amongst them—in 1889, 1890, and 1891—I was always received with much cordiality. Felt tents were often erected for me in advance, sheep brought as presents, and all assistance given me; and, indeed, they seemed to have considerable respect for me, on account of my having actually visited Peking, the city of the great Khakan-i-Chin, the Emperor of China, an almost fabulous personage to them, and possessed, they imagine, of unbounded resources of wealth; the most potent ruler in the world, and the controller of armies, which could hurl destruction on all who opposed them. It is curious, indeed, with what superstition and reverence China is regarded by these Kirghiz and the inhabitants of Turkestan, none of whom have ever visited

the country, but who have to draw their own conclusions regarding it from their not very truthful conquerors, and from the fact that for centuries the Chinese have held their own in these remote regions, in spite of numerous attempts to overthrow their power. This last point, especially, is one which has great weight with all the people of Central Asia; and the prestige of the Chinese stands very high, from their having so determinedly and so frequently reasserted their authority with such unerring certainty.

I have interested myself much, too, both during my journey in 1887 from end to end of Chinese Turkestan, and again on my recent journeys in Kashgaria and the Pamirs, in examining the way in which the Chinese rule a conquered race, and comparing it with our own methods in India. I think the first impressions of an inquirer are rather unfavourable to the Chinese. They do little or nothing for the good of the country, they seldom improve the roads or construct canals, and education, except training a few natives as interpreters in Chinese, is almost entirely neglected; few or no officials speak the language of the country, and they are consequently very largely in the hands of their native interpreters; both the Chinese and native official accept bribes, and justice is often difficult to obtain; and, lastly, the punishments meted out are often very barbarous and cruel. Yet, in spite of all these very grave defects in their administration, I do not think that the Chinese are at all so unpopular as might be supposed. The natives have become accustomed to them, they do not look for or expect a highly civilised administration pure of every blemish, and they have had experience that, under Mahommedan rulers, they have been quite as corruptly, or even more corruptly governed; while what has, perhaps, most weight of all with them, is the fact that under the Chinese they are much less heavily taxed than they were under their own kings. Closer inquiry, too, shows that glaring instances of oppression are not really frequent, and, on the other hand, cases are not unknown where corruption has been very severely reprimanded. The cruel and barbarous punishments, too, occur but seldom. When a Chinese official does punish a man, he punishes him with extreme severity, and makes a lasting example of him; but, as far as I could ascertain, unless there was real necessity for doing so, the Chinese deal out punishment as rarely as possible.

The true secret, however, of the success of the Chinese, in addition to their prestige, is undoubtedly their perfect mastery of the art of impressing Orientals. We English in India are sometimes supposed to be too haughty and exclusive, but we might be considered low and familiar compared to the Chinese. It has its disadvantages, as they cannot possibly get in real touch with the people, but the Chinese system of extreme exclusiveness undoubtedly produces some good results. A Chinese district officer, even one of quite inferior rank, lives in a fine, large house, surrounded with high walls, and approached by massive gateways. He never appears in public except dressed in his neat silk official robes, and accompanied by an escort; and, most important point of all, he both pays the greatest respect to his superior and insists on it from those under him, while even his equals he always meets with dignity. A Chinese official, in fact, respects himself, and consequently is respected by others; and this is the grand secret why, with a very small force and at so great a distance from their capital, they are able to keep a conquered people in quiet and contented subjection.

Time does not permit me, however, to enter more fully into this subject, and before concluding this paper I must say a few words regarding the Kanjutis of Hunza, who have made such an impression upon all the country in the vicinity of the Pamirs. This tribe of robbers inhabit the deeply-cut valley which runs from the apex of Central Asia where the Hindu-Kush and Himalayan systems meet, and the watershed between eastern and western Asia joins that between northern and southern. They seem to be a remnant of the original Aryan stock which had overflowed from the first starting-point of their race to the north of the Hindu-Kush, and to have been left shut up in this secluded valley, while most of the other branches and off-shoots of the parent stock have been swept backwards and forwards by the tides of conquest, and drifted into far off and remote countries. Such a people cannot fail to excite one's curiosity, and the interest was naturally heightened in my case from having heard so much of their raids and bold forays in the countries through which I passed, before entering their secluded valleys. I found them to be small, well-built, hardy, determined, though not fierce-looking men, wearing long black curls, which gave them a very wild appearance. Perhaps the most remarkable feature about them is their capacity for en-

durance. They issue from their strongholds on their raiding expeditions, and cover often 200 miles of mountainous and uninhabited country, entirely on foot, and carry their own supplies for the whole distance on their backs; and I have known the cases of men carrying news of my movements to their chief in incredibly short spaces of time. Dressed in long cloaks of thick home-made woollen material, they sleep out in the open in the most intense cold, and yet live upon almost nothing. I remember on one occasion giving some Kanjutis who were accompanying me 2 lbs. of flour each, and was told that this was a regular feast for them for three days. Another characteristic of them is their avarice. Like most people they will not do anything for nothing, but they even seem to expect to get something for doing nothing. Money they did not appear to care about, as they scarcely appreciate its value, and when I gave a few of them some rupees they asked the Gurkhas of my escort what they were worth. The Gurkhas, with a cleverness for which they are not usually remarkable, would hold out a handful of tobacco and say, "Well, if you give me a rupee I will give you this much tobacco." Those that have been towards Gilgit and Kashmir are, of course, better aware of the true value of money, and all wish something and keep demanding presents for every little service rendered. The late Chief Safder-Ali-Khan was never tired of demanding things. I had given him and his Wazir a number of presents which should have been amply sufficient to satisfy them; but, unfortunately, I had given the Wazir a few pieces of soap wrapped in tinfoil paper. This seems to have excited the envy of the Chief, who had received none; for he promptly sent down two men, asking for some to give to his wives. Even when I had refused him, and told him that I had given him all that I ever intended to give, he used, day after day, to keep sending messages to me for every imaginable thing, down even to my tent and my mule trunks. The people seem to live mostly by agriculture, and are principally congregated in the lower part of the valley, where it opens out opposite Nagar. The produce of the fields, however, is scarcely sufficient for their wants, and they have to supplement it by living a great deal on apricots and other fruits, which are grown in considerable quantities. In the upper valleys they have flocks of sheep and goats, but they are very small, and not very numerous.

Such are the people whose chiefs have recently received at our hands the just punishment for their numerous misdeeds, and it is sincerely to be hoped that the peaceful cultivator in his village home near Gilgit, the indolent Kirghiz tending his flocks on the Pamir, and the enterprising trader wending his way across the mountains to Yarkand, may now enjoy that sense of security which this little robber tribe have denied them for centuries.

And here I must end this imperfect description of a region which has lately come so prominently into notice; a region replete with interest alike to the man of science, the student of languages, and the statesman; and the point at which the territories of the two great European rivals—or may I not say allies?—in the civilisation of Asia most nearly approach each other.

DISCUSSION.

The CHAIRMAN said they were all much indebted to Captain Younghusband for his very valuable paper. Everyone who had heard the very modest account he had given of what travellers in that region were exposed to, must entertain feelings of the highest admiration for those who underwent such hardships. What struck him most was the great stress laid on the very severe cold which had to be encountered, a matter which always appealed to the "gentlemen of England who lived at home at ease." They all sympathised with those who took part in Arctic expeditions, but what impressed them most was not the danger so much as the excessive hardships from cold which they had to endure. But except in the few cases where he had to leave his ship, the Arctic explorer had always the comfort of his cabin to resort to, and many Arctic travellers said that even in the bitterest weather they could manage to keep the ship itself almost uncomfortably warm. The travellers in the Pamirs had no cabin, and under no circumstances could he make his tent uncomfortably warm. Captain Younghusband's explorations had been of extreme value, not only to geographical science, but to the Government of India. The tracts he had explored were now assuming for the first time political significance, and, in dealing with political questions, the first essential was an intimate knowledge of the country in question. Having been lately connected with the Government of India, he could say how highly Capt. Younghusband's services were appreciated. It was said by a Latin author that poets were born, not made; and he thought the same would apply to adventurous travellers. Sir Roderick Murchison, the eminent geologist, began his career as an officer of dragoons, and Captain Younghusband did the same. He could hardly help saying, when he

saw the captain in evening dress, as if he thought of nothing but going to his club or into society, and then saw him mentally on one of his expeditions, with only two servants, with all their provisions carried on one pony, that he was a sort of geographical Dr. Jekyll and Mr. Hyde, appearing first in one character, and then in a totally different one. Mr. Andrew Lang, in one of his essays, spoke of explorers as representing the best type of English character, and remarked on the curious craving for fresh adventures, almost like that of a drunkard for alcohol, which always seized such travellers. When such a man got into what was termed a tight place, he would say, "Catch me here again," and sure enough you did catch him there again; and he had little doubt that, in a few months' time, Captain Younghusband would be on the war-path again. Until quite recently he belonged to the 1st Dragoon Guards, but the Government of India were so averse to losing his services that, when his regiment went home, they succeeded in breaking through the rules, in order that he might exchange into another regiment, and his services had now been secured permanently for the Indian army. He had no doubt that he would go on, and add many more to his list of achievements.

Lord CREMORNE said Captain Younghusband must often have found himself in an uncomfortable position, the nearest parallel to which that occurred to him being that of the adventurous Swedish professor, who not long ago traversed Greenland with a very small party. He had one advantage, however, in not having any doubtfully hospitable people to meet, the interior of Greenland being probably only uninhabited.

Sir HALLIDAY MACARTNEY, K.C.M.G.. said there were plenty of Englishmen who had the courage to lead a troop of horse, but to bear aloft—"Through snow and ice, a banner with this strange device, Excelsior!" required a very different and superior kind of courage. The country described was of great political interest at the present time, and it was astonishing that the heart of the oldest civilised continent should have remained until lately almost as unknown as the heart of Africa. The point of political equilibrium of Asia must be said to be changed many degrees further east; for while formerly they looked to Herat and Candahar as places of great importance, attention was now more directed to a point beyond the Mustagh Mountains, where the three great empires of China, Russia, and England met. He had listened with great pleasure to the testimony which had been given in favour of the Chinese, with whom he had so long been connected. He accompanied the Marquis Tsêng to St. Petersburg, after the region of Kuldja had been annexed by Russia, and lent him what assistance he could; and when the marquis succeeded in getting it restored to China, Lord Dufferin paid him the compliment of saying that he had accomplished what no man had ever done before, he had made Russia give back a province she had once annexed.

Mr. W. MARTIN WOOD said it was well to recollect that the pioneer in this modern exploration of high Asia was a member of the old Indian navy, the discoverer of the sources of the Oxus, and from that point, which was thought so striking at the time, one could measure how immensely our knowledge had been extended since. He thought the reader of the paper was a little hard on the Hunzas in describing them as brigands, and so on; for the photographs which had been shown seemed to offer some excuse for them, as it was difficult to see where they could find anything to live on, and they were no doubt driven to get their living how they could. Captain Younghusband had spoken of their receiving a just punishment from our troops, but that might be open to question, for they had never robbed our people or interfered with them. That was only an illustration of the extraordinary position in which we found ourselves in that region, where, as Captain Younghusband had said, our influence was constantly extending. It was our influence which had been pushed from within, not from without. Not much had been said about the Nagaris, but it was interesting to remark both on their similarity and contrast to the Hunzas, though they were of a similar race. They were superior to the Hunzas probably owing to their more fertile soil, and perhaps superior religion, or better customs with regard to other people. Speaking of English influence in high Asia, he would refer to the paper by Sir Alfred Lyall in the *Nineteenth Century*, in which he expressed the hope that England would not go on extending her boundaries, and thus increasing the responsibilities, which must weigh on the minds of reflective Englishmen.

Mr. OLIVER WILLIAMS, referring to the last sentence in the paper, said he hoped England and Russia might rather be allies than rivals. That time last year, he was travelling for some eight months through the Arctic seas, across a great part of Siberia, and came home through St. Petersburgh; and both the principal officials in Siberia and the ministers in the capital expressed their great desire for friendly intercourse and friendly exchange of commercial relations with England. They said that such a vast empire as Russia had ample work within its own territory which required developing in every way. There were vast regions which still required railways, canals, and other works which could only be carried out at great expense, and which must be assisted in such a country by the Government, who also had a great deal to do at present in connection with the famine. Russians were most desirous to show a friendly spirit to the English, and if we would only reciprocate it, great good would

result. His own experience with regard to the cold was, that while travelling night after night, with about 50° of frost, Réaumur, he did not feel the cold. One reason was that you were well wrapped up in furs and woollens, and, the other, that when the cold was so intense the air was always very calm.

The CHAIRMAN then moved a vote of thanks to Captain Younghusband, which was carried unanimously.

Captain YOUNGHUSBAND, in reply, said the kindness and appreciation which he received at home was a great encouragement to the traveller when wandering about in the wilds of Central Asia. He, like most travellers, had thought at times that he would never go in for that sort of thing any more; he had said so many times when crossing the desert on his way from Peking, on the glaciers, when exploring the northern frontier of Cashmir, and on the bleak and cold Pamirs; but when the traveller returned to his native country, and saw that an interest was taken in what he had done, and that people would still be interested in further journeys he might make, he felt his energies renewed, and was quite willing to undergo the hardships which must necessarily befall him, feeling that he was doing something for his government and his country.

Miscellaneous.

TRANS-SIBERIAN RAILWAY.

The *Board of Trade Journal* quotes the following from Dr. Meyners d'Estrey's article in the *Journal des Economistes* on the proposed railway across Siberia :—

"After the grand work of General Annenkoff in Central Asia, Russia has recently formed the project of constructing a still more gigantic railway. This is a line through Asia terminating on the Pacific Ocean and intended to connect the Chinese system with the European systems.

"The distances for the contemplated Trans-Siberian Grand Pacific are as follows :—From Tjoumens to Tomsk, 1,300 kilometres; from Tomsk to Irkutsk, 1,700 kilometres; from Irkutsk to Oustj-Strejelka, 1,300 kilometres; from Oustj-Strejelka to Oussouri, 1,600 kilometres; from Oussouri to Vladivostock, 500 kilometres. Total, 6,400 kilometres.

"This line will, therefore, exceed in length any of the Trans-American lines. In fact, that of Canada, opened in 1884, has only a length of 5,071 kilometres; the North Pacific, opened in 1883, 5,293 kilometres; the Central and the Union, opened in 1883, 5,260 kilometres; the Santa-Fé line, opened in 1881, 4,875 kilometres; the Atlantic and Pacific, 5,631 kilometres; the North Pacific, opened in 1883, 6,251 kilometres.

"The proposed line will meet few difficulties in connection with the level of the country; but the large rivers flowing from south to north, and which must be crossed by the line, will necessitate the construction of very expensive bridges. Thus, it appears, the opinion has been expressed that these rivers might be dealt with temporarily by means of boats. In winter the journeys would be made on the ice by means of movable rails. Such might be done for Lake Baikal, in order to avoid the great detour of 200 kilometres, which would have to be made by the line in order to pass to the south of this lake.

"The rivers to be crossed would be the Tobol at Tobolsk, the Irtysch at Omsk, the Ob to the east of Tomsk, the Tom at Tomsk, the Yenissei at Krasnojarsk and other arms of rivers of lesser importance.

"The system of crossing the river by means of ferry boats on which the carriages are placed is already employed at many places in Europe, among others near Hamburg; it works rapidly and does not cause any loss of time.

"The bridges which would have to be constructed over the rivers should be extremely substantial; they would have to resist the floating ice to be met with for a long period of the year in Siberia. This would, therefore, necessitate enormous expenditure.

"Further, there are other obstacles, such as the Yablonoi mountains, 1,150 metres above the level of the sea. But this altitude is really much less when it is seen that the passage through these mountains is situated 400 kilometres from the east coast of Lake Baikal, and that this lake itself is 409 metres above the sea-level.

"In the Amour valley the only question of difficulty will be that of the Oussouri. The eastern extremity of the line as far as the Pacific Ocean, near Vladivostock, will then be easily reached.

"It is difficult to form an estimate of the cost of these constructions. The Trans-Caspian line, which was inaugurated in 1888, cost about 32,000 roubles per verste (verste = ·633 of a mile), but it is most probable that the Grand Trans-Siberian will cost more, especially if it is desired to establish bridges across the rivers, which will sooner or later be inevitable in order to prevent delays and the continual expense of the transhipment of passengers and merchandise.

"The rivers may be crossed by ferry-boats in summer, and on the ice, when safe, in winter; but the ice drifts incessantly between these two seasons, and then the question of crossing becomes somewhat difficult of solution. This question has been put to General Annenkoff, and he counts on the construction of the line without bridges.

"This line has given rise to two proposals: one emanates from the Ministry of Public Works, the other is that of General Annenkoff. The Ministry of Public Works engages to construct the Trans-

Siberian within thirty years, and at a cost of 480,000,000 roubles; General Annenkoff only asks for four years and 300,000,000 roubles. It is probable that the system of the General will be accepted. Already the Ministerial Committee has given him its approval. He has also the support of the Ministries of War and Finance.

"The advantages presented by the Trans-Siberian are many. First for Russia, it will place St. Petersburg and Moscow in communication with its possessions on the Pacific Ocean, notably with the large military port of Vladivostock. It will permit Russia, in the event of a war with China, to rapidly muster an army on the frontiers of the Chinese Empire, and from a commercial point of view it will secure to Russia the situation as intermediary between Europe and the countries of the extreme East, such as China, Japan, and Corea. It will carry passengers and a large portion of the goods which, at present, take the sea-route in order to be forwarded from Europe to the extreme East and *vice-versâ*.

"The journey from Western Europe to Shanghai at present takes 44 days by the Suez route, and 34 days by the Trans-Canadian railway. It will be only 20 days by the Trans-Siberian.

"Along a large portion of the Trans-Siberian route, cultivation may be carried on over an area of land equivalent to the width of France from east to west, between the Vosges and the ocean. It will not be long before cultivation is commenced. When the Trans-Caspian was built, the country in which this railway of 1,000 kilometres was situated was only a desert. Now cotton is planted there with great success. Central Asia produces ten times more cotton than before the existence of the Trans-Caspian railway."

Correspondence.

BURNING OILS FOR LIGHTHOUSES AND LIGHTSHIPS.

As there was very little opportunity for discussion after the reading of Mr. E. Price Edwards's paper on "Burning Oils for Lighthouses and Lightships," I desire, with your permission, to correct a misapprehension that may probably arise from the remarks offered by Mr. Boverton Redwood, when he states that the definition of "inflammable liquid," in relation to lighthouse oil in the recent Inflammable Liquids Bill, was not objected to by the delegates of the Scotch oil companies.

The reason for this reference to the Scotch producers in his criticism of Mr. Edwards's paper is not quite apparent, and, to many who are not familiar with the history of petroleum legislation, it may be somewhat misleading.

It is well known that the Scotch producers, ever since the first Petroleum Bill of 1862, have on all occasions when the question of safety came under discussion in Parliament, or was the subject of investigation by Parliamentary committees, contended strongly for a high standard. But in the trade conferences of 1891, the question of the standard of safety was purposely never under discussion, as the general provisions of the Draft Bill submitted for their consideration were felt to be so onerous, that united trade action had become a necessity, in order to prevent serious, if not fatal, injury to the trade in mineral oils generally.

During 1891, however, the Scottish Mineral Oil Association, which comprises practically the whole of the oil producers of Scotland, issued a statement in regard to the Inflammable Liquids Bill, in which referance is specially made to the absurdity of lighthouse and other oils with flash points over 150° F. being brought within its scope, by the introduction into that Bill of quite a novel qualification, viz., specific gravity. That statement further says, "The subscribers desire to emphasise the fact that they have always maintained a standard of safety much above the requirements of any Act of Parliament; and that their mineral oils have, in consequence, stood the test of experience under all circumstances and in all climates, and have been practically free from accidents, either of conveyance, storage, or in use in lamps. To brand their manufactures, therefore, with the stigma that exceptional measures and precautions require to be adopted in their case would be manifestly unjust."

I may be permitted also to make some reference to the very remarkable statement which Mr. Redwood makes as to the result of experiments conducted by Sir Frederick Abel and himself, viz. :—"That substantially it was found that a lamp might be said to be in the safest condition when the space above the oil in the reservoir was filled with vapour." Now, if this is to be taken seriously, it is clear that Dr. James Young, the founder of the industry with Sir Lyon Playfair, and a host of other scientific men who have given special attention to this subject in England, in Germany, and in America, have been wrong in insisting that oils for domestic use should be high-test, with a minimum flash-point of 100° Fahr. That the more educated classes also, and public companies—such as railways, steamships, and lighthouse Boards—have all been erroneously seeking safety in high-test oils; and that the various Government departments, guided by Sir Frederick Abel himself, have been making a strange mistake in declining to use oil, even in a soldiers' camp, with a lower flash-point than 105° Abel test.

Mr. Redwood appeals from the few isolated experiments made by Mr. Edwards to the experiments made by the million every night, with lamps, in their own houses; but surely the sad scenes depicted from hospital experience by the late Mr. Charles Marvin, were enough to show that Mr. Edwards' experiments are oft repeated in the homes of the poor with

equally sensational, and too frequently with much more tragic results.

The unsafety of higher test oils, Mr. Redwood says, may arise from their volatilising slowly, and thus more liable to produce an explosive mixture. But the experiments of Mr. Edwards have frequently been confirmed by many other operators, that the temperature of oil in lamps rarely ever rises above 90° Fahr. after five or seven hours' burning, and usually it varies from 76° to 90° Fahr. High test oils, therefore, which give off no vapour under 100° Fahr. never reach the point in ordinary domestic lamps at which vapour can be produced, and, consequently, safety in their use is insured.

On the other hand, oils which begin to give off inflammable vapour at 76° to 90° Fahr. are exposed to such temperatures in the reservoirs of lamps, and are, therefore, maintained just at the point when volatilisation is least active; and it follows from this theory of Mr. Redwood's that 75° to 90° flashing oils are precisely the oils most dangerous to use under ordinary domestic conditions.

From an experience of 30 years with a great variety of lamps and oils, and having examined many cases of so-called lamp explosions, I should say that an explosion, in the true sense of the word, seldom, if ever, happens. What I have found is, that vapour, escaping from the lamp, flares up the chimney, or the vapour may take fire inside the lamps, and, under such circumstances, from the heat produced, the chimney breaks, or the reservoir may crack, or the soldered parts become disconnected; but, in the great majority of lamp accidents, the cause is either upsetting the lamp, or dropping it through carelessness, or from alarm when any flaring takes place. When a lamp is upset which contains oil that gives off vapour from 75° to 85° Fahr., the chances are, that the vapour and oil take fire, as they escape from the lamp, and the greater the volume of vapour present, the greater the risk.

The very exhaustive experiments conducted by Dr. W. Thörner in Germany, confirm our practical experience that the risk from any actual explosion in lamps is extremely small. He discharged an electric spark in the space above the oil in the lamp reservoir, and the result in nearly all the trials was merely a swishing noise, followed by the extinction of the flame, so that the energy of the slight explosion expended itself harmlessly up the wick tube. The explosions took place at temperatures varying from 76° to 84° Fahr., in the case of the ordinary commercial petroleum flashing at 74° to 80° Fahr. There were three explosions that were more violent than the others, and these were with oils flashing at 77° to 80° Fahr. The highter test, Water White and German Kaiser oil, did not produce an explosion till the oils reached 116° and 109° Fahr., and in these cases the explosion was slight.

We venture to think that practical experience fully justified Dr. Thörner in the opinion he expresses, that a petroleum which does not give off any explosive vapour at 100° Fahr. Abel test, may be used anywhere in Germany or in England with the most perfect safety.

William Love.

Obituary.

M. H. Blanchard.—Mr. Mark Henry Blanchard, the well-known terra-cotta manufacturer, died, in the 76th year of his age, on the 1st inst., at his residence, Bishop's Waltham, Hants, after a short illness. He was one of the earliest revivers of the use of terra-cotta, and, at the Great Exhibition in 1851, he obtained the prize medal for material and workmanship in terra-cotta. He carried out some of the most extensive works with this material throughout the country, more particularly those in the South Kensington Museum and the Gardens of the Royal Horticultural Society. Mr. Blanchard's premises were originally in the Blackfriars-road; but when the ground upon which they stood was required for public purposes, he removed to more extensive premises in Hampshire. As late as December of last year, a new invention of his for a fireproof staircase and flooring in terra-cotta was tested with, it is said, satisfactory results. Mr. Blanchard had been a member of the Society of Arts for nearly 30 years.

Sir James Caird, K.C.B., LL.D., F.R.S.—Sir James Caird, who died on Tuesday evening, 9th inst., although not a member of the Society of Arts, took great interest in the work of the Society. In December, 1857, he presided at a meeting, when a paper "On the Progress of the Agricultural Implement Trade" was read by Mr. S. Sidney; and he had promised to take the chair on April 18, when Sir William Wedderburn will read a paper before the Indian Section on the "Reorganisation of Agricultural Credit in India." During the 44 years between these two dates, he presided, on several occasions, at meetings devoted more particularly to the discussion of agricultural subjects. Full biographies of Sir James Caird have appeared in *The Times* and other papers, and it is not therefore necessary to do more here than set down the dates of the chief particulars of his life. He was the son of Mr. James Caird, of Stranraer, born in 1816, and educated at the High School and University of Edinburgh. Sir James Caird was M.P. for Dartmouth from 1857 to 1859, and for Stirling from 1859 to 1865. In 1860 he was appointed a Member of the Fishery Board, and, in 1863, became Chairman of the Royal Commission on the Sea Fisheries of the United Kingdom. He was appointed on the Famine Commission, to inquire into the circumstances of the great famine in India of 1876-7; C.B. in 1870, and K.C.B. in 1882; President of the Statistical Society, 1881-3; Member of the Royal Commission on Land Law (Ireland) Acts, 1885-7. He was also Senior Land Commissioner for England.

Sir James Caird was the author of several works on agriculture, which passed through numerous editions, and were translated into foreign languages.

General Notes.

CHICAGO EXHIBITION.—The *Austrian Gazette* publishes the nomination of Archduke Charles Louis, the Austrian Heir Apparent, as patron of the Austrian Section of the Chicago Exhibition. The Marquess Bacquehem, Austrian Minister of Commerce, is appointed President of the Austrian Commission, which further comprises five Vice-Presidents and seventy-five others as members of the Central Committee, and, finally, fifteen members of the Executive Committee. This is the strongest official body on record in this country connected with an International Exhibition, showing that Austria intends to be largely represented at Chicago.—*Standard.*

FRENCH SAVINGS BANKS IN 1891.—According to a report recently issued by the Minister of Commerce upon the situation of ordinary savings banks in France, it appears that the number of such banks existing in 1891 was 544, with branches to the number of 1,062. The number of new accounts opened during the year was 513,690, a falling off, as compared with the preceding year, of 12,175. The total number of accounts open at the end of the year was 5,936,825, and the amount of deposits during 1891 was 835,894,734 francs (£33,436,000). The total amount standing to the credit of depositors was 3,052,311,372 francs (£122,092,000). The *Monde Economique*, in reviewing the returns, calls attention to two remarkable points in connection with these statistics—the diminution of what may be termed active saving, and the augmentation of savings to which the word passive may be applied, by reason of the capitalisation of interest. The number of new accounts, which was only 513,690, amounted, in the previous year, to 534,865, whilst the total number of accounts open rose from 5,761,408 in 1890, to 5,936,825 in 1891. There is therefore a falling off in the savings, which points to a less prosperous condition of affairs. The deposits during the year have followed the same descending scale, and amounted to 835,000,000 francs in 1891, as compared with 869,000,000 in 1890. And yet the amount standing to the credit of the various depositors has risen from 2,911,000,000 francs in 1890, to 3,052,000,000 last year.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

FEBRUARY 24.—ERNEST HART, "Ancient and Modern Art Pottery of Japan." Prof. WILLIAM ANDERSON, F.R.C.S., will preside.

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention."

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

Papers, the dates of reading of which are not yet fixed :—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Foreign Exchange." By EWING MATHESON.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock ; due notice of the hour will be given :—

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru." 8 p.m.

APRIL 5.—The Rev. JOHN McLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19. — JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 23.—J. WILLIAM TONKS, "Artistic Treatment of Jewellery: Jewel and Address Caskets." Sir PHILIP CUNLIFFE-OWEN, K.C B., K.C.M.G., C.I.E., will preside.

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

There will be no meeting on March 8, as previously announced. This will be replaced by a meeting on May 31.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

LECTURE I.—FEBRUARY 29.—*Properties and Uses of Petroleum in Prime Movers.*—Oil testing—Specific gravity, flashing point, composition—Expansion—Distillation—Vaporisation of oils—Spray-making and carburetting devices in modern oil-engines—Pressure of petroleum vapours at different temperatures—Behaviour of different kinds of oil in engine cylinder—Other properties of petroleum as heating and working agent.

LECTURE II.—MARCH 7.—*Petroleum Oil-engines.*—Heating of oils—Mixing and firing of charge in the internal combustion engine—Use of regenerator—Modes of governing—Practical tests—Study of indicator diagrams—Efficiency—Present economy and future possibilities.

LECTURE III.—MARCH 14.—*Oil Gas.*—Gas generator and internal combustion engine *versus* steam-boiler and steam-engine.

LECTURE IV.—MARCH 21.—*Oil Fuel and Gaseous Fuel for Steam-boilers.*—Safe heavy oils available—Different methods of burning oils—Injector-burners—Evaporative power of oil fuel.—Advantages and disadvantages of liquid fuel on steamships—Transport and storage of petroleum—Other uses of petroleum for power purposes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 22 ... Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. J. Theodore Bent, "Journeys in Mashonaland and Explorations among the Zimbabwe and other Ruins."
British Architects, 9, Conduit-street, W., 8 p.m. 1. Mr. R. Herbert Carpenter, "The Subject of Painted Glass: Introductory." 2. Mr. James Powell, "Some Details and Technicalities of the Glass-painter's Art." 3. Mr. N. H. J. Westlake, "Fairford, Winchester, and King's College (Cambridge), as Models for Modern Work." 4. Mr. Clement Heaton, "Stained Glass of the Renaissance Period, and the Use of Enamel."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. L. Gomme, "Popular Superstitions and Traditions."

TUESDAY, FEB. 23 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. William Tonks, "Artistic Treatment of Jewellery: Jewel and Address Caskets."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture VI.)
Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m.
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m. Mr. H. Ling Roth, "The Natives of Borneo." Part II. Edited from the papers of the late H. Brooke Low, Esq.

WEDNESDAY, FEB. 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Ernest Hart, "Ancient and Modern Art Pottery of Japan."
Geological, Burlington-house, 8 p.m.
Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.
Patent Agents, 19, Southampton-buildings, W.C., 7.15 p.m. 1. Discussion on Mr. Ellis's and Mr. Newton's Papers. 2. Mr. J. Imray, "Provisional Protection."

THURSDAY, FEB. 25...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Shelford Bidwell, "Experimental Meteorology."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "Some Recent Biological Discoveries."
Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

FRIDAY, FEB. 26 ..United Service Institution, Whitehall-yard, 3 p.m. Colonel J. R. Rothwell, "The Reconnaissance of a Railway: its Utilisation and Destruction in time of War."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting 9 p.m. Sir David Salomons, "Optical Projection."
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. S. P. Thompson, "Modes of Representing Electromotive Forces and Currents in Diagrams." 2. Prof. Maurice Fitzgerald, "The Flexure of Long Pillars under their own Weight." 3. Prof. J. Perry, "Choking Coils."

SATURDAY, FEB. 27 ... Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Rev. G. F. Browne, "Early Christian Art in England."
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture III.)

The Telegraphic Address of the Society of Arts is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,049. Vol. XL.

FRIDAY, FEBRUARY 26, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

UNION OF INSTITUTIONS.

The following institution has been received nto Union since the last announcement.

Goldsmiths' Company Technical and Recreative Institute, New Cross.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of this Committee was held on Wednesday, 24th inst. Present:—Sir Frederick Leighton, Pres. R.A. (Chairman of the Committee), Philip H. Calderon, R.A., F. Seymour Haden, F.R.C.S., H. Stacy Marks, R.A., Walter William Ouless, R.A., Lumb Stocks, R.A., W. Hamo Thornycroft, R.A., the Earl of Wharncliffe; with Sir Henry Trueman Wood, Secretary of the Royal Commission, and J. W. Beck, Secretary of the Committee.

PHOTOGRAPHIC DEPARTMENT.

Photographic apparatus and photographs are classified under Group 151 (instruments of precision, experiment, research and photography, photographs), which is included in the Department of Liberal Arts.

Photo-mechanical prints and processes, photogravures, &c., are classed under Group 76 (photo-mechanical and other processes of illustrating), which is, like lithography and printing generally, included in the Department of Machinery.

All the photographic exhibits, however, wil be placed together in the portion of the Liberal Arts and Manufactures Building allotted to the British Section.

Screens will be fitted up for the exhibition of photographs, photogravures, and other pictures produced by photographic methods.

For the space on these screens the charge will be 2s. 6d. per square foot, with a minimum charge of £2.

Exhibitors desiring to erect their own screens or stands can do so. In that case they will be charged for the ground they occupy according to the same scale as other exhibitors.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

February 16, 1892; The Hon. John X. Merriman, M.L.A., in the chair.

The paper read was—

THE FORTHCOMING EXHIBITION AT KIMBERLEY.

By Lewis Atkinson.

The idea of holding an International Exhibition at Kimberley was suggested by some of the inhabitants, and the Mayor called a meeting at the Town-hall, which was attended by all the leading townspeople. The idea being favourably received, committees were at once formed, and a guarantee fund started. It was considered that £12,000 guarantee would be quite sufficient, but the proposal was taken up so heartily that, in a very short time, about £20,000 was guaranteed, the Government giving a donation of £1,000 as a start off, the De Beers Consolidated Mines guaranteeing £2,000, the Kimberley Borough Council £1,000, the Hon. Cecil Rhodes £500, the Hon. B. I. Barnato £500, Messrs. Wernher, Beit & Co. £500, and all the large merchants about £250 each. On this side, a guarantee fund has not been started yet, but it is known that the shipping companies, banks, diamond merchants, and African merchants generally, are all willing to promote the interests of the Exhibition by making very substantial guarantees.

It was decided that the Executive Com-

mittee should consist of those only who had guaranteed the large amounts and the chairmen of the various committees, so that they might be perfectly certain that the money was expended in the best and most economical manner.

There have been Exhibitions held in the Cape Colony before, but none of so much importance, or of an International character.

RAILWAYS.

One of the many reasons that the Exhibition should be held at Kimberley is, because, thanks to the railways, it commands an exceptionally central position. It is close to the borders of the Orange Free State, Bechuanaland, and Transvaal; within reach of Natal; and the English visitors can reach it from Cape Town (647 miles) in 29 hours, or from Port Elizabeth (485 miles) in 27 hours; and travelling in the most comfortable manner in a kind of Pullman car train, fitted up with every comfort, and lighted by the electric light.

The Cape Colony has, indeed, not been lagging, when once it turned its attention to railway communication. In 1870, there were but few railways in the country; to-day, there are three trunk lines in the Cape—

	Miles opened.	Miles to be opened.
Western System:		
Cape Town to Vryburg, *viâ* Kimberley	864	41
Midland System:		
Port Elizabeth to Graaf Point, ,, Colesberg, ,, De Aar	734	
Eastern System:		
East London to Aliwal North.	292	121
	1,890	162

Total mileage, 2,052; cost, £16,261,846.

The Western system is to be extended to Mafeking.

The Midland system is being carried on through the Orange Free State to the Vaal River, and thence, through the Transvaal, to Johannesburg Gold Fields.

The year 1891 has witnessed the opening of rhe Natal-Charlestown line, in connection with which, and other railway works, the Colony spent some £4,000,000, and the opening of which was the occasion of festivities of great magnificence. Towards the close of last year Mr. Sivewright journeyed to Pretoria in connection with the railway policy of the Transvaal Government, and after carrying through some most interesting negotiations, succeeded in obtaining for the Cape Colony advantages of great importance. The Commissioner arrived in Pretoria towards the end of November, and on December 8th the Transvaal Executive gave its assent to an agreement by which the Cape Colony obtains special running powers over the Netherlands Railway Company's lines, which amount to partial control of the Johannesburg-Pretoria section of the Netherlands line, upon which a fixed tariff is to be used. The extension of the railway from Bloemfontein to the Vaal River is proceeding apace, under the Convention which received the approval of Parliament in July last. The section to Kroonstad is expected to be open for traffic early in this year. By the time the Exhibition is opened it is hoped that the railway will reach Johannesburg, but our Chairman can give you the latest particulars.

The traffic earnings on the Cape railways, which are under Government control, reached £1,986,674 in 1891, against £1,771,154 in 1890, an increase of £215,520.

The ordinary fare from Cape Town to Kimberley and back (first-class) is over £12, but the Cape Government are anxious to assist the Exhibition in every way, and are making special arrangements that visitors to the Exhibition shall do the same journey for about £3 10s., and exhibitors who take a certain amount of space will have a free railway ticket.

Telegraph Lines in Cape Colony, 1890.—Total miles of line, 4,640; miles of wire, 11,791; cost, £393,423.

Of what use, some of you may ask, can an Exhibition at Kimberley be to English trade, and of what interest to English visitors? Well, I will invite your attention to a few statistics giving a brief but clear indication of the importance of South African trade to Great Britain, and I will attempt to show that, as the Exhibition must work for the further extension of that trade, it is necessary that Great Britain should be well represented in every branch. If she does not make a good exhibit, other competitors, always anxious for an opportunity, may do her an injury. I may mention that I have already received information that Holland, Germany, Italy, Norway, France, Canada, and America are all proposing to exhibit. I will show what South Africa imports and what she exports; but before taking the trade statistics, I will give you the census return.

The Governments of the South African States

decided upon taking a census of the population during 1891. The arrangements for the Cape Colony were left in the hands of Mr. Henry de Smidt, the present Under Colonial Secretary, who earned the warmest congratulations for the admirable manner in which a census of the most comprehensive nature was carried out. Returns since made public have shown the total population of the Colony to be 1,527,224 persons, comprised as follows:—

Europeans	376,987
Malays	13,907
Hottentots	50,338
Fingoes	229,680
Kafirs	608,456
Mixed	247,806

Population of Cape Town		51,083
" Suburbs		29,063
" Port Elizabeth		23,558
" East London		6,858
" Kimberley,	28,644	39,121
" Beaconsfield,	10,478	
" Grahamstown		10,436
" King Williamstown		7,193

I may mention that Kimberley is a most cosmopolitan town, as it contains English, Scotch, Irish, Welsh, French, Germans, Italians, Norwegians, Swedes, Russians, Dutch, Portuguese, Greeks, Indians, Arabs, Chinese, Malays, and every variety of native. The Free State population was returned as 206,600, composed of 77,000 Europeans or whites, and 129,600 of other races. The census of Natal showed the population to be 543,913, the whites being 46,788, Indians 41,142, and natives 455,983, or ten blacks to one white. As to the Transvaal, £6,000 of public money was wasted in an attempt to take a census, a *fiasco* was the result, and although returns were published to the effect that the European population of the country numbers 119,128, they are not regarded as at all accurate. No census of the natives was taken.

In 1890, South Africa imported £13,780,000 worth of goods, an increase of £8,500,000 in five years; and exported produce to the value of £7,186,812, exclusive of diamonds—an increase of £2,500,000 in five years.

TRADE RETURNS OF CAPE COLONY FOR 1891.

Imports.

Merchandise	£7,518,000
Colonial Government Articles	1,054,000
Specie	10,000
Total	£8,582,000

Exports.

Produce	£3,979,000
Diamonds	4,174,200
Gold	2,781,570
Specie	14,790
Non-Colonial	181,250
Total	£11,130,810

It is estimated that the imports to Kimberley amount to over £2,500,000.

DISTRIBUTION OF CAPE TRADE, 1890.*

Imports.

United Kingdom	£6,944,022
British Possessions	630,480
	£7,574,502
Foreign Countries	896,048
Grand Total	£8,470,550

Exports.

United Kingdom	£9,692,656
British Possessions	64,318
	£9,756,974
Foreign Countries	212,191
Grand Total	£9,969,165

PORT ACCOUNTS, 1890.*

	Imports.	Exports.
Cape Town	£2,738,566	£2,064,005
Port Nolloth	15,565	694,355
Simon's Bay	2,465	—
Mossel Bay	150,909	53,893
Kuysua	9,950	5,049
Port Elizabeth	3,995,858	1,998,125
Port Alfred	2,865	—
East London	1,502,046	991,093
St. John's River	612	635
Inland Stations	51,714	—
Kimberley	—	4,162,010
Totals	£8,470,550	£9,969,165

EXPORT OF WOOL, 1890.*

lbs.	Declared Value.
65,655,917	£2,196,040

I find that wool, for years the staple industry of the country, yields a return of close on £3,000,000; mohair and ostrich feathers, hides and skins, represents a yearly value of £1,250,000; copper ore, averages £650,000 per annum; and, of recent years, native gold has been gaining, in leaps and bounds, over other products.

Gold Output.—Last year the export of raw gold from the Transvaal reached £2,792,472. In January of this year the export of gold

* Similar details for 1891 not yet published.

through the Cape ports reached £330,000, as against £177,000 in January, 1890, this being at the rate of £3,500,000 a year. In 1885, the total output of raw gold was valued at £64,540; it rose to £909,000 in 1888; and, last year, it was £2,750,000, a gain of £2,500,000 in seven years. Last year no less than 52 Witwatersrant mines paid dividends ranging from 1 to 50 per cent., averaging 8½ per cent. The total capital issued in connection with the Randt mines is £14,036,540; the market value is £9,420,000. There were last year 2,260 heads of stamps in the gold-crushing batteries, and these crushed 1,275,828 tons of ore, yielding 720,980 ounces of gold, An industry which, in seven years, has doubled its returns 42 times, is entitled to our highest respect and admiration. In 1888, when the output had not reached £1,000,000, there was what is called a "boom," and some millions of English capital went out to the Transvaal for investment, often in the rashest and most foolish manner, on the bare representation of designing men. The market was inflated, people speculated wildly in scrip, and the industry itself suffered. The result was, of course, inevitable. The "boom" collapsed, like a punctured ball, involving, I am afraid, many in ruin, and giving a bad reputation to South African mines. English speculators did not suffer alone, for the whole fabric of South African trade was shaken to its centre, through the closing of three Colonial banks, the managers of which had caught the prevailing mania and gambled in shares. South Africa recovered from that blow in a most surprising manner. The Hon. J. X. Merriman, our chairman to-night, carried a Bill through Parliament, altering the banking law, guarding against a repetition of rash financing; and, to-day, the Cape and South Africa enjoy the services of institutions, conducted by able men, on the soundest and safest lines.

On October 24th last year, the deposits on current accounts in banks doing business in the Cape reached £4,660,000, and the deposits, payable after notice, totalled £3,170,000.

Not only did general commerce quickly recover from the blow, but the gold mining industry—that most seriously affected—went on increasing at still greater bounds. As we have seen, the output in 1888 did not reach £1,000,000, while last year it reached almost £3,000,000.

We have seen that South African pastoral pursuits, as represented in the supply of wool, mohair, hides, skins, and feathers, yield between £3,000,000 and £4,000,000; diamonds I will speak about later. Gold, £2,750,000; copper ore, £650,000; whilst the coal mines in Natal, Cape, and Transvaal are increasingly valuable. Mining and pastoral pursuits are, however, yet in their infancy, and the limit for expansion should be very large—how large I should not care to say.

The gold-fields in the Transvaal, Witwatersrand, and Mashonaland have yet to be fully developed. The coal deposit has been merely tapped, and the miner's occupation, is, it may safely be said, lasting.

The latest mining return of the British South African Company shows that 3,151 prospecting licenses have been issued, and that 16,355 claims have been registered. From this the mining population may be inferred, as prospecting licenses are only issued at the rate of one per man, and the latest private letters I have received says that there was little rain this season, and that large parties are flocking into the country, and that well-arranged towns are now being made.

Then, as to the stock farmer, his day has yet to come. We have not, in South Africa, such cattle ranches as they have in America, or such sheep runs as they have in Australia, but Bechuanaland invites the stock raiser, and the wide flats of Kalihari, on the authority of reliable travellers, offer good feeding ground for vast herds of cattle. Of the agriculturist we have as yet said nothing, but his occupation is one capable of almost larger development than that of the pasturist. With a fine healthy climate and a rich soil, with ports three weeks nearer London than Australian ports, the South African agriculturist has a fine prospect before him; and he has made a start in the development of a new, and, I hope, prosperous industry, in sending fruit to the London market.

Now that I have touched on the prospects of South African trade, I would ask the English manufacturers whether it will not be to their advantage to take part in an exposition of their trades. The goods chiefly in demand in South Africa are haberdashery and millinery, apparel, cotton manufactures, hardware and ironmongery, leather, boots and shoes, saddlery, machinery, cast and wrought iron, cabinet ware, oilman stores, spirits, carriages, soap, jewellery, musical instruments, guns, locks, and cutlery. In all these lines there should be good exhibits of English manufactures. I was told before I left

Kimberley that there is and will be a still greater demand for light transport, both aerial and rail, concentrating machinery, crushing machinery, rock drills, well-boring, dynamos, motors, electric lighting for mines, scientific, optical, and photographic instruments. Educational appliances are greatly needed. Gas-making machinery, both from mineral oil and coal, will also be in demand, now that we no longer depend on English coal, at about £8 15s. per ton, but have a supply, close at hand, of colonial coal, which is coming freely into the market. We shall want, also, good gas-making apparatus for lighting and cooking purposes, and the coke will be of use for smelting, as the silver mines in the Transvaal are being very greatly developed. Tents, transport waggons, portable house travelling equipments of all kinds to suit the goldseekers and hunters; also portable furniture.

In all these lines there should be good exhibits of English manufactures. People who have made fortunes prefer making a home there to returning to this country, and their houses are fitted with every luxury and comfort. At the last Paris Exhibition many visitors from the Cape bought works of art, pictures, furniture, and have them in their homes now. These houses now are nearly all being supplied with the electric light.

Trade does not always follow the flag, it sometimes goes into foreign bottoms, and our friends across the water, both in Germany and in the United States, are keen competitors, with a reputation for pushing their own interests. I have received letters from people in Canada not only to say that they wished to exhibit, being fully alive to the fact that this offers a splendid opportunity of opening business with a sister colony, but stating they hope to make up a large party of Canadian manufacturers, merchants, and agriculturists, to visit Africa during the Exhibition, and to find out the best way to push their businesses and in many cases settle in the country. I would point out that Colonials will go the Exhibition to learn something, and it may safely be predicted that every English exhibitor will have cause to be thankful that he displayed his goods. From every part of South Africa will flock people of every trade and occupation, bent on finding out machinery which will lead to the saving of labour or the development of industry. Every bit of machinery, from an elaborate stamp battery to a sewing machine, every article of workmanship, and every manufacture in use in South Africa, together with rare pieces of art, tasty millinery from West-end houses, and all the various ornaments and luxuries that go to make up the pleasure of living, as well as those that provide the material for living on, and those that help to provide the means to live at all, all these will be carefully examined by appreciative judges, by miners and farmers, by merchants and sportsmen, by wives and sweethearts, all bent upon purchasing something. The manufacturer who does not exhibit goods that are in demand in that large and growing country will regret his want of enterprise.

The Exhibition, as I have said, is being well supported by the Cape Government. They started by giving a donation of £1,000, and have arranged that the Exhibition shall be a bonded warehouse; therefore, there will be no duty charged on unsold exhibits.

The Government have made arrangements with the railway department to carry all goods intended for exhibition to and from Kimberley free of charge, provided they remain the property of the exhibitor. If, however, any exhibit brought by rail is sold, the exhibitor will have to pay the ordinary rates.

It is hoped that the Government will make arrangements for caretakers in charge of exhibits to be allowed to travel free per rail second-class (or, upon paying the difference, travel first-class), provided that they have paid for, and occupy, a space of not less than 30 square feet, and, further, that the exhibits of which they are in charge are in the same ownership on the return journey.

The Government are going to lay a siding from the main line so that the railway will go straight into the Exhibition. The Government have decided that during the Exhibition they will run cheap trains from Cape Town to the Exhibition.

The *personnel* of the Exhibition is as follows:—

President.—His Excellency Sir Henry Brougham Loch, G.C.M.G., K.C.B., &c., Governor of the Cape Colony, and Her Majesty's High Commissioner.

Vice-President.—The Hon. Cecil John Rhodes, Premier of the Cape Colony.

Patrons.—The Right Hon. Lord Knutsford, G.C.M.G., H.M. Secretary of State for the Colonies; his Excellency Lieut.-Col. Sir Charles B. H. Mitchell, K.C.M.G., Governor and Commander-in-Chief of the Colony of Natal; his Honour Sir Sidney G. Shippard, K.C.M.G., Administrator of British Bechuanaland; his Honour Lieut.-Col. Sir M. J. Clarke, R.A., K.C.M.G., Resident Commissioner, British

Basutoland; his Honour S. J. P. Kruger, President, South African Republic, and the Members of the Volksraad; his Honour F. W. Reitz, President, Orange Free State, and the Members of the Rand; the Hon. J. W. Sauer, Colonial Secretary; the Hon. J. X. Merriman, Treasurer of the Colony; the Hon. J. Rose-Innes, Attorney-General; the Hon. James Sivewright, Commissioner of Crown Lands and Public Works; Sir Charles Mills, C.B., K.C.M.G., Agent-General for the Cape Colony; the Hon. Sir Gordon Sprigg, K.C.M.G.; the Hon. Sir Thomas Upington, K.C.M.G., Q.C.; Sir John Henry de Villiers, K.C.M.G., Chief Justice; the Hon. Mr. Justice Smith; the Hon. Mr. Justice Buchanan; Sir Jacob D. Barry, Judge President, Eastern Districts Court; the Hon. Mr. Justice Jones; the Hon. Mr. Justice Maasdorp; the Hon. Mr. Justice Laurence, Judge President, High Court, Kimberley; the Hon. Mr. Justice Solomon; the Hon. Mr. Justice Cole; the Mayors of the various towns of the Cape Colony, Natal, and the South African States; Captain Hollis, Consul for the United States; A. Ohlsson, Esq., Consul-General for Sweden and Norway; C. H. Knight, Esq., Consul for Belgium; E. Von Treskow, Esq., Consul-General for Germany; A. De Carpini, Esq., Consul for Italy; E. A. De Carvalho, Esq., Consul for Portugal; Chamber of Mines, Johannesburg.

Chambers of Commerce.—Kimberley, Cape Town, King William's Town, East London, Port Elizabeth, Durban, Maritzburg, Bloemfontein, Pretoria, and Mafeking.

In London, every assistance and support is being given to the Exhibition. The Right Hon. Lord Knutsford, G.C.M.G., H.M. Secretary of State for the Colonies, is a patron, Sir Charles Mills, C.B., K.C.M.G., is the Chairman of the Executive, as the Cape Government asked him to give his valuable aid. Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., is on the Executive, and he, as you know, is the grandest organiser. Every exhibition has been a great success whenever he has been at the head of it, and I have to thank him for the very valuable assistance he has rendered us already; then we have Sir George Chubb, a gentleman of great exhibition experience, who has given valuable assistance.

Sir Donald Currie, K.C.M.G., M.P., as representing the De Beers Company, has very kindly taken in hand the Fine Art Section; and Sir Frederick Leighton has kindly consented to act on the Fine Art Committee; and there is little doubt that fine art will be better represented than it ever has been in Africa before.

Mr. H. A. Hedley, who has for many years been connected with exhibitions, and was the successful manager of the first Edinburgh Exhibition and the Glasgow Exhibition, is also giving valuable practical help. The two mail companies are represented by Mr. Farmer, for the Union Steamship Company, and Captain Wisely, for the Castle Company. The African merchants are represented by Mr. G. M. Mosenthal, of Messrs. M. Mosenthal, and Mr. J. Paddon, of Messrs. Hill and Paddon. Mr. C. Posno, represents the next largest and wealthiest company in Kimberley and De Beers, being chairman of the London and South African Exploration Company, and the North-East Bultfontein Diamond Mining Company; and the Press is represented by Mr. E. P. Mathers, editor of *South Africa;* and, on the London General Committee, we have Sir Somers Vine, a practical exhibition gentleman, and some of the leading African merchants.

The shipping companies have decided to assist the Exhibition in every way, and the British and Colonial Steam Navigation Company (Messrs. Bucknall Bros.), 22, Crutched-friars, have offered the most generous terms, and such that have never been given to any other Exhibition. They are prepared to convey exhibits outwards at current rates, and to bring back to Great Britain any unsold exhibits that were taken out by them free of homeward freight, and refunding the amount previously paid for outward freight on such unsold exhibits. Therefore, exhibitors will have their goods carried by ship 6,551 miles, by rail, 485 miles, and, if not sold, the same distance back, free of charge.

The Castle Mail Packets Company (Donald Currie and Co.), 3 and 4, Fenchurch-street, E.C.; Union Steamship Company, 94 and 96, Bishopsgate-street Within, E.C.; South African Line, Billiter-house, Billiter-street, E.C.; International Line, Rochester-building, 138, Leadenhall-street, E.C.; Clan Line, Leadenhall-buildings, Gracechurch-street, E.C., have intimated that they will be prepared to make special arrangements with exhibitors for the conveyance of their exhibits outwards or homewards.

Messrs. Divine Gates, of Cape Town, have informed me that they are appointed the official agents at Cape Town, and will only be too pleased to help all exhibitors and visitors

to the Exhibition. Messrs. Rodwell and Co., of Port Elizabeth, are the official agents at that town, and will forward all exhibits on by train, making a small charge, and also the dock charges.

The Exhibition buildings will be situated in the Botanic-gardens. The main buildings will cover 50,000 square feet, and there will be a gallery which, in Africa, will be a novelty. The building has one main avenue, and off this four separate wings, to contain the British, Continental, Canadian, American, and Fine Art sections. I do not know for certain what the building will be built of, but expect it will consist of wood and iron, and special arrangements will be made to protect the Fine Art Sections. It has been decided not to use glass for the skylight, but "Duroline" from the New Wire Wove Roofing Company.

The machinery will be put in a separate hall, and this will be one of the great features, as the Mining and Machinery Committee are giving their hearty support, and are going to award gold, silver, and bronze medals, also diplomas, and have forwarded to me the conditions for competition in rock drilling, &c.

The buildings are to be erected by May 15th, and I have received instructions that the De Beers Consolidated Co. have made arrangements to buy the main-building and machinery-hall really before they are erected.

The Exhibition offers a splendid opportunity for manufacturers of machinery to increase their business in South Africa, as the Mining and Machinery Committee consists almost entirely of gentlemen who are mine managers or in charge of machinery. Johannesburg intended holding an Exhibition about August, this year, but abandoned it, and they have now formed a committee there to help the Kimberley Exhibition, and these gentlemen will all be now at the Exhibition, and will not only practically test the machines, but will be able to find exactly the sort they require. This morning I received a cablegram from Kimberley to say Randt Chamber of Mines officially offer gold medals for machinery. We have their hearty support.

Agricultural machinery and implements will be greatly appreciated, as the Executive are now arranging to have a large Intercolonial Agricutural Cattle Show, and the Pretoria Agricultural Society have promised to give every assistance to the Exhibition, and also render pecuniary aid. The Executive are also arranging with the Government to try and have a grand review of all colonial volunteers, so that camping, equipments, guns, &c., would be thoroughly appreciated; and it is intended that all scientific meetings, conferences, &c., shall take place during the Exhibition.

The Exhibition will be opened on Sept. 1st, and remain open for above three months. The committee reserve to themselves the right to extend or shorten the period during which the Exhibition shall remain open.

An influential Committee, under the presidency of the Mayor, has been formed to deal with the accommodation of exhibitors and visitors during the Exhibition.

All the larger exhibits, or such as require special fittings, must be delivered not earlier than the 15th of July, nor later than the 15th August, and must be accompanied by attendants qualified to place them in position, unless special arrangements are made. Smaller exhibits can be delivered after that date, but not later than the 25th of August, 1892. All must be arranged and ready for exhibition before the 1st September. Exhibits proffered after these dates may be received, but no guarantee is given that they will either be catalogued or submitted to the jurors.

The charge for space will be as follows:—For floor space (other than machinery in motion), not exceeding 25 square feet, 5s. per square foot; for floor space exceeding 25, not exceeding 50 square feet, 4s. per square foot; for floor space exceeding 50, not exceeding 100 square feet, 3s. 6d. per square foot; for floor space exceeding 100, not exceeding 200 square feet, 3s. per square foot; for wall space, half the above rates; for outside space for sheds, 2s. per square foot.

The Executive Committee reserve to themselves the right to refuse any exhibit, without stating the reason for so doing. If no space is allotted the money paid will be refunded, and where only a portion of the space applied for is granted, a proportionate amount will be retained and the balance refunded.

British and Foreign applications will be received in London until March 1st, 1892. A sketch of the space required, and an elevation, showing the character of the exhibit, will greatly assist in the arrangement of the spaces. Whatever vacant space exhibitors require around their exhibits, beyond the usual passages, must be paid for. As the space is limited it would be advisable to send in the application as early as possible. Applications for space for machinery in motion must be made on special forms, which will be supplied on application to the London office.

The London Committees, whilst cordially acting in conjunction with the committees in Kimberley, and the Manager, in forwarding, so far as they can, the interests of the Exhibition, and of intending exhibitors and others, by supplying prospectuses and applications for space, and otherwise assisting and facilitating the objects in view, desire to make it known that they will not be responsible either individually or collectively for any loss, damage, or expenses of any kind whatever connected with the Exhibition, or with the preparation and transmission of exhibits or otherwise by whomsoever incurred.

All information can be had at the Agent-General's (Sir Charles Mills) offices, 112, Victoria-street; or of myself, at the Exhibition offices, 3 and 4, Fenchurch-street.

Kimberley is situated 4,050 feet above sea level. The mean temperature is 70° in summer, and 50° in winter. It is a well-planned town, with twenty miles of streets, and attractive shops. The houses are all built of brick, improved drainage, and a plentiful supply of water from the Vaal River. The town is lighted by the electric light. The Kimberley Club is the most roomy and best arranged in the colony, and the able secretary, Captain Tyson, looks well after the comfort of all members and visitors.

There are four principal diamond mines. Kimberley Mine, which is situated in the town; the De Beers Mine, also situated in the town, close to the Exhibition-grounds; Bullfontein Mine, 2½ miles to the south of De Beers, and Du Toits Pan Mine (close by these two), are situated in Beaconsfield.

The De Beers Consolidated Mines have now practically the four mines in their hands, and have lately purchased the Wessleton Mine.

For 16 years following 1867 there were no accurate official returns of the exact weight and value of diamonds produced in the several mines. Since that date careful monthly statistics are collected by the chief of the detective department at Kimberley. But even now, notwithstanding the stringent penal laws against illicit diamond dealing, it is well known that a very large per-centage of the gems do not reach their lawful owners.

Taking the best available estimates for the years from 1867 to 1882, and the official returns for the subsequent years up to December 31st, 1891, the total value of diamonds produced in the Griqualand West Mines reaches the enormous sum of over £57,000,000 sterling. For the past year the value exported was £4,174.200.

Some authorities believe that the actual produce of the mines during the 25 years of working is at least one-fourth more than the official returns, so that, if that be correct, we get the enormous total value of £71,000,000 sterling; and there is no indication of any diminution of production.

The effects of the diamond discovery on the commercial interests of Cape Colony, it is hardly necessary to say, have been most marked. It occurred at a time when the colony was suffering from severe trade depression, which it gradually dispelled, as is shown by the revenue returns, which have since that period steadily risen from £617,826, in 1867, to £4,430,050, in 1889-90, per annum.

At the present time about £2,000,000 sterling is spent in wages annually by the De Beers Company at Kimberley.

It is not my business to-night to trace the history and uses of the diamond, and if it were, far different, let me say, would be my conclusions from that drawn by Lord Randolph Churchill, who seemed to find no other reason or motive for the diamond industry than woman's vanity and its gratification.

There is no doubt that the diamond industry has helped civilisation, increased present prosperity of South Africa, developed the railway system, brought capital into the country, and, better than that, brought new life and fresh blood from every part of the world—from America, Australia, from the Continental countries, and from Great Britain, men flocked to the new Eldorado. In that great rush there naturally were included many rogues, but each country contributed some of its best material, and South Africa has not ceased to appreciate the services of some of these. In mentioning one name which is most conspicuous, the Honourable Cecil J. Rhodes, present Prime Minister of the Cape, I am reminded of the fact that the present splendid position of the diamond mines is greatly due to his foresight, and he is pursuing the same work now in the development of Mashonaland and Matabeleland.

Before leaving the De Beers Consolidated Mines, I should like to say that every member of that company is helping the Exhibition; and at the annual meeting, held in Kimberley, September 24th, 1891, Mr. B. J. Barnato, acting chairman of the company, in his speech to the shareholders, said these words :—

"Gentlemen, before drawing my remarks to a close, there is one subject which I should like to mention briefly, because our company will be inti-

mately associated with it, as a project which is calculated to attract a great deal of attention to the products, the industry, and the enterprise and resources of South Africa. I refer to the Exhibition which is to be held in Kimberley towards the end of next year, and the exact title of which is comprehensive enough—the South African International Exhibition, Kimberley, 1892. You are aware, gentlemen, that our company has placed a certain sum upon the Guarantee Fund for that undertaking, and we have done so for two chief reasons. The first is that we recognise the propriety of such an institution as ours, and so powerful an industry as the diamond industry, assisting by every means in our power an undertaking of so useful and beneficial a character. And in the second place, however much we may be convinced as to our almost exclusive ownership of the diamond wealth of the world, it is but right that we should take every means in our power to instruct and educate the people, as it were, in the extent and magnitude of our mining operations, the splendid appliances here in use in Griqualand West for the winning of our diamonds, and, in fact, the whole economy and method of an industrial and productive and financial corporation which has not its equal in the whole world. In aiding and supporting this proposed Exhibition we thus not only do good to the town, which we are ever anxious to do, but we shall also let the world know by practical means, and best of all, by machinery in motion and by the actual manipulation of blue grounds and diamonds, from start to finish, what labour, what outlay, what anxiety, care and forethought, are required in the finding of those precious gems which I hope will in a short time yield a greater profit than ever to the shareholders of our company. Not only have we as a company subscribed to the Guarantee Fund of the Kimberley Exhibition, but many of us individually have done so, and I am sure that shareholders generally, whether resident here or in Europe, wish this admirable scheme the most brilliant success."

The De Beers Co. are supporting the Exhibition in every way, as Sir Donald Currie represents them in London on the Executive; three of the directors at Kimberley, Messrs. B. J. Barnato, L. Breetmeyer, C. E. Nind, are on the Executive there; Messrs. Gardener T. Williams, general manager; L. J. Seymour, the engineer; and Mr. H. Craven, the secretary, is treasurer.

What attractions are there to induce English visitors to the Exhibition ?

First, there is one of the finest sea voyages in the world, and both the Union and Castle Mail Companies will act very generously in reducing the fares. Messrs. Cook, the world-renowned tourists' agents, take charge of the visitors, as they are appointed the passenger agents, and they will undertake the arranging of tours for visitors. Then there is the lovely scenery around Cape Town; then up to Kimberley, and, besides seeing the Exhibition, the directors of De Beers will kindly allow all visitors to the Exhibition to inspect the diamond mines and see the whole of the diamond industry, and if they desire it, they can then go on to the gold-fields, then on to Natal, and back home.

Mr. T. W. Goodwin, ex-Mayor of Kimberley, is appointed the African agent, and has visited a large number of the African towns, and has received every support.

If ever the late Prince Consort's idea of an Exhibition were realised, it will be in this case, as it will advance education, increase business relations with all countries, and greatly tend to increase that good feeling that already exists between the various Governments and people in South Africa.

DISCUSSION.

Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., thought every one would agree with him that they had listened to a most interesting paper. As an old member of the Society of Arts, he felt very much pleased that they had had the honour of having a distinguished statesman in the chair that evening; and, as a member of the London Executive Committee of the Kimberley Exhibition, he congratulated them that the chairman had shown so much interest in the proposed Exhibition as to be present that evening. He (Sir Philip) felt honoured at having been asked to be a member of the London Executive, and to act under his old friend, Sir Charles Mills, with whom he had had the pleasure of working in connection with the Colonial and Indian Exhibition. The strength of the London Executive was the worthy chairman. As an old exhibition man, he might say that the outcome of all exhibitions was business; and if British manufacturers would only exhibit their wares at the Kimberley Exhibition, he was sure they would meet with a fitting reward. He had no doubt that the invitation to manufacturers would be loyally responded to; and he was certain that all those who exhibited would have reason to be grateful for the sacrifices they made, as they would establish a business in Kimberley which would be to their own benefit, and to the lasting benefit of this country. He had had the pleasure of working with Mr. Atkinson on many occasions, and knew that he was capable of doing all that he promised.

Mr. BEWICK said he had been very much interested in the paper, and from what he knew of South Africa, he was sure that all visitors to the Exhibition would thoroughly enjoy themselves. He should be glad if

Mr. Atkinson would give them some assurance that visitors would be able to find sufficient hotel accommodation.

Sir PHILIP CUNLIFFE-OWEN said he had no doubt that if Messrs. Cook had undertaken to look after the travelling public, there would be sufficient accommodation provided.

Sir CHARLES MILLS, K.C.M.G., C.B., said the subject of accommodation had been fully considered by the Executive Committee in London, and he had not the slightest doubt that accommodation would be found for all visitors.

The CHAIRMAN, in proposing a vote of thanks to the author of the paper, said that with regard to the question of accommodation, it must be recollected that the Cape was not like London, and visitors could put up with a trifle less accommodation there than here, owing to the excellent climate. He thought Mr. Atkinson was very courageous to have read a paper at all about the colonies at the present time, seeing that in England there were waves of feeling with regard to them. Sometimes there was a tremendous gush in favour of the colonies, and at other times there came a sort of blizzard. At the present time the colonies were suffering from the latter. During the jubilee year enough could not be said in favour of the Australian colonies. They were urged to enter into all kinds of expenditure, which they did, and two or three years after they were told that they were running too far. A good deal of this feeling came from an insufficiency of knowledge, and in his opinion the Exhibition was about the best thing calculated to remove this feeling. If people knew more about the colonies, he did not think there would be this extraordinary feeling that the colonies were going to set the world right, neither would they have the occasional cold snaps. He was perfectly certain at the present time, if there were more knowledge of the colonies they would not have the extraordinary feeling of depression with regard to the colonial securities. Anyone who took the trouble to study the colonies and their wonderful resources, would see how well able they were to pay their way. At the Cape the people were a steady-going class with regard to financial operations, and when they found that the British public were not ready to lend them money, they lent it to themselves. The depression now going on would have a good effect, if it merely taught colonists to be more self-reliant, The colony which he had the honour to represent had assisted itself; at the present moment they were about to raise a loan to the extent of £1,000,000, having already lent themselves £2,000,000 upon a previous occasion, though that fact was not known in England. About one-eighth of their whole debt would be held by the people and institutions of the colony. That was a healthy state of affairs, and he hoped the Australian colonies, which had far more resources than the Cape, would imitate them in that respect. If all the British colonies did that, they would not find capitalists in London looking askance at them. Mr. Atkinson had given them so many figures that he would not attempt to add to the number; but he must just mention that the Cape Colony managed last year to export about £3,000,000 worth more goods than it imported. This was a healthy sign for a borrowing colony. A remark had been made as to there not being enormous sheep farms in the colony as in Australia. This was very true, and he was glad to say it was so, for instead of having a few squatter kings, as they were called in Australia, the farms in the colony were each managed by their owners. This developed the resources of the country. More white population was needed, and in this respect the Exhibition must do a great deal of good. There was no need to try and induce people to come and develop mines, for they would come fast enough. The diamonds spoke for themselves, and the gold was now beginning to speak. What were wanted were those who would come and settle on the land. One industry which, he believed, was destined to have a very great future, was the fruit industry. This was attracting many people to Australia, and also to California and Florida. Quite lately, this industry had been put on a commercial footing, by the successful importation of peaches and grapes in the English market, which had been sold at a good profit, leaving a handsome return for the growing. This industry was capable of a very great future indeed, and it left an opening to many young men, with a small amount of capital, and who liked a country life. In connection with this subject, he might be permitted to say that he viewed with a certain amount of alarm a statement that lately appeared in the newspapers, that "General" Booth was proposing to select the Cape Colony as the place for his first experiment of an over-sea colony. He felt bound to say that the population of the Cape Colony would resent this very much indeed, for a worse place could not have been selected for the experiment. It was a place where drink was cheaper than in any other part of the world; and as the people to be sent to found the new colony would doubtless be taken from a class which had not succeeded here in consequence of intemperate habits, it would be folly to send them to a warm country where drink was so cheap, and where there was a great black population of no morality at all, and where among the great industries was gold mining, which was of a gambling character. In the name of his Colony, he felt bound to protest against the experiment being made. He did not know why "General" Booth, who had not been received with any amount of enthusiasm at the Cape, should have selected this Colony; and he hoped that he might re-consider his decision. He did not wish to cast any stones at the extraordinary manner in which the propaganda was arried on, but, while wishing well to the scheme,

he must enter a protest against the Cape being selected as the proposed field of the operation. Coming back to the paper, he thought the Exhibition would be a means of spreading information with regard to South Africa. The one thing wanted, to judge South Africa impartially and fairly, was to have more knowledge of it, which would be obtained from the Exhibition. Mr. Atkinson had already shown himself to be a most successful man at this kind of work, and the success of the diamond industry at the Colonial Exhibition was largely due to him.

The vote of thanks was carried unanimously.

Mr. ATKINSON, in reply, said that the hotel accommodation had been the subject of great consideration by the Executive Committee at Kimberley, and before he left the colony he was informed by the hotel keepers that they would support the Exhibition by keeping prices down to the ordinary tariff. The Executive Committee in London knew that it was a most important matter that visitors should be comfortably housed, and this week he had received a letter from the Kimberley Executive Committee to the effect that a committee had been formed, of which the Mayor was chairman, to look into the question of hotel accommodation. He had not the slightest doubt that there would be sufficient accommodation for everyone. The Exhibition was sure to be a success, as all the leading firms had promised to exhibit.

APPLIED ART SECTION.

Tuesday, February 23rd, 1892; Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., in the chair. The paper read was "Artistic Treatment of Jewel and Address Caskets," by J. WILLIAM TONKS. The paper and discussion will appear in next week's *Journal*.

ELEVENTH ORDINARY MEETING.

Wednesday, February 24, 1892; Professor WILLIAM ANDERSON, F.R.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Blanchard, Mark Henry, Bishop's Waltham, Hants.
Courtenay, J. Irving, 1, Essex-court, Temple, E.C.
Farlie, John Burke. 128, Eglinton-road, Plumstead, Kent.
Goodenough, Lieut.-General William Howley, C.B., Blomefield-house, Shooters'-hill, Kent.
Langton, Alfred, Deptford Pier, S.E.
Macpherson-Grant, John D.L., Ballindalloch, N.B.
Smith, Henry Wells, 8, Norfolk-row, Sheffield.

The following candidates were balloted for and duly elected members of the Society:—

Ashburner, Lionel Robert, C.S.I., 9A, Gloucester-place, Portman-square, W.
Hervey, Hubert J. A., 12, Lowndes-street, S.W.
Hughes, John, Chester, and 16, Great George-street, S.W.
Jex, Edward, 27, St. Mary-at-Hill, E.C., and the Dukeries, Springfield, Chelmsford, Essex.
Riekmann, Adolph, 59, Knightrider-street, E.C.
Sessions, Frederick, Russell-house, Gloucester.
Simpson, Edward Henry, 100, St. Martin's-lane, W.C.
Smith, W. A., Houghton-house, Arundel.

The CHAIRMAN, in introducing the reader of the paper, said it was some five years since Mr. Hart instructed them by a series of lectures upon almost every form of Japanese art, and since that time he had visited Japan. Mr. Ernest Hart had now seen the various *fabriques* and studied the production of Japanese art from the point of view of a connoisseur and collector. The best connoisseur was the collector, and the best of all collectors was the connoisseur, both of which qualifications Mr. Hart possessed.

The paper read was—

ANCIENT AND MODERN ART POTTERY AND PORCELAIN OF JAPAN.

BY ERNEST HART.

Member of Council of the Japan Society.

I had the honour of dealing with the subject of Japanese art work before an audience composed of the members of the Society of Arts in May, 1886. The time which I was able to devote then to Japanese porcelain and pottery was very limited. It has been, however, a satisfaction to find that the summary classification of schools and masters which I ventured to present has been since widely adopted both here and in Japan. That part of my lecture which related to pottery and porcelain has been reproduced *verbatim* by that enlightened and appreciative student and writer on the art work of Japan, Mr. Marcus Huish, who did me the honour to apply to me for authority to do so, in his excellent and popular handbook of the arts of Japan; and, when I recently visited Japan, the first book put into my hands, or, rather, laid on the table of my room, on arriving at the hotel in Yokohama, was a complete report of the lecture published by Mr. Deakin, whose enterprise and taste has done so much to favour the best work of the modern Japanese artist, and whose collections at once open to the traveller in Japan a full and very attractive view of the best work of the best

artists of to-day. I was further encouraged by finding, later on, that a good deal of the text of the lectures which I gave in this theatre, and which were re-printed from the *Journal*,* had been translated into Japanese, and were extensively circulated among the Japanese, and valued by them as a handbook and critical discussion of the merits and characteristics of the schools, periods, and masters of old Japan, in a little book which I have here in my hand. The edition is now nearly exhausted, but I still frequently receive applications for copies—(I did so this week from the Leyden Museum)—and these are often accompanied by such cordial assurances from amateurs and students that they rely largely upon those lectures and the accompanying index of authors and signatures as their guide, that I am induced once more to take up some parts of this interesting study. I have greatly added to my imperfect knowledge of this great subject, and largely added also to my collection of specimens of the finer varieties of old work during a recent visit to Japan, in which I had the opportunity of examining an immense number of specimens in public and private keeping, and of selecting from some choice private collections examples of the rarer kinds of work, seldom seen in Europe. For these opportunities I was largely indebted to the peculiar kindness of leading members of the Government, among whom I owe my acknowledgments to Count Okabê, Count Kuki, the head of the department of fine arts, an accomplished and devoted curator of the art treasures of Japan, and to Mr. Hamao, the Minister of Education. In no less a degree was I indebted to the kindness of Mr. Okakura, the head of the art schools and acting chief of the museum at Uyeno, whose European studies have been added to Japanese erudition and taste, and to Captain Brinkley, of Tokio. Captain Brinkley is no less remarkable for his thorough accomplishment as a Japanese scholar, than for his enthusiasm, judgment, and research as a critic and collector. He is *facile princeps* in many departments, but as as authority in keramics he stands alone. We are all expecting his promised *magnum opus* on the subject, of which I saw the beautiful plates and a large part of the letter-press.

Armed with official recommendations to the Governors of the provinces, and supplied by them with courteous attendant officers (Mr. Kobayashi and Mr. Maeda), who had opened to me all the temple stores, the private collections, the priest's godowns, and the public treasures; and, aided by the critical judgment of some of the most acute of Japanese experts, I was able to enjoy, in the course of a few months, such a revelation of the variety, originality, and richness of Japanese art work as was beyond imagination, and could hardly otherwise have been achieved in the course of years.

Circumstances also enabled me to become possessed of the private collection of old Satsuma, which had been slowly accumulated, for his own delectation, by Mr. Maizan Tabui, whose name is celebrated throughout the world as the most accomplished of Satsuma artists; while the kindness and energy of Mr. Wakai, of Tokio, the inspirer of the great work of M. Gonse, and the parent of the best European collections, put me on the track of some of the finest few remaining keramic treasures of Japan still available to the enterprise of European collectors. For so few now are the available masterpieces of old work, that the systematic search for them on the spot for the European market has almost ceased. Little arrives here but skilful forgeries of old work or the dregs of the market, after the Japanese Imperial household, the native collector, or the agents of the public museums at Tokio or Osaka have had their choice; and the skilled French collectors who used to traverse Japan have been withdrawn.

I wish I had time to describe to you to-night, as I hope to describe at some time elsewhere, the excitement and the humours of the hunt for *antiques* in Japan. A Japanese auction of the old style at Kioto is a subject worthy of the pencil of a Hogarth: the unfailing courtesy of the modern Japanese curio dealers—that is to say, of those who supply the globe-trotter—is only equalled by their profound and ingenious duplicity, their unblushing but imperturbable humbug. Suffice it to say, that out of thousands upon thousands of pieces of pottery which I saw offered for sale and sold to globe-trotters, rarely one per cent. were genuine, or in any sense valuable; and but for the honesty and trustworthy skill and capacity of some of the few "old Japanese" dealers, such as Wakai, Daisho, Daizen, Fukiu, and Fukuda, and the opportunities from private collections in all parts of Japan, which I owe to the kindness of the introductions from the gentlemen I have mentioned

* Lectures on "Japanese Art Work," by Ernest Hart, delivered before the Society May 4, 11, and 18, 1886, with a catalogue of objects exhibited, and an Index of Japanese artists. London: 1886.

above, I should have come away nearly empty-handed. As it was, I was able—after curious adventure, and after having to read a very severe lesson before official authority to one of the larger dealers—to bring away, after three months' incessant hunting through accumulations in out-of-the-way places and the available stores of all the dealers, and collectors, and connoisseurs, lay and ecclesiastical, nearly a thousand specimens in all of objects in different departments of ancient art, which had been passed through the most critical tests.

The keramics of Japan are confessedly the most ancient and the most characteristic of its art products, and those which have most immediately and extensively influenced European work. Our literature has been enriched by our Chairman, by Mr. Gonse, and others, with monographs on glyptic and pictorial art, while pottery and porcelain have not been dealt with in so authoritative or satisfactory a manner. I propose, therefore, to-night to take a further step in that direction.

I wish to put before your eyes authentic specimens of the leading kilns of Old Japan; examples of the most characteristic works of its potters; and illustrative varieties of the peculiarities of the older glazes, paste, and decorative style, to which the Japanese attach most importance, and which seem to me most to deserve the attention of the artistic connoisseur. For the description of them and their historic details, I shall rely wholly upon the dicta of Captain Brinkley, whose words I shall use throughout and whose authority I shall follow, for I am persuaded we shall nowhere else find so safe a guide. The details furnished in his paper in "The Chrysanthemum," in the extracts illustrating his exhibited collection in New York, and in his chapter contributed to the works of Mr. Chamberlain and Mr. Norman, furnish a body of information which leaves little to be desired, except that they be, as we are promised that they will be, collected, condensed, and illustrated in a great forthcoming work. Meanwhile, in directing your attention to the specimens I put before you, you will please remember that it is for the most part Captain Brinkley who is speaking, and that it is to his erudition and judgment that we are indebted for the text by which I ask you to judge the examples which your eyes will enable you to study. This is, to-night, rather a demonstration than a lecture; the researches, and largely even the words, are due to Brinkley. I want you to distinguish and to judge the things described. I am very sorry that the exigencies of space in the lecture theatre compel me to restrict my selection to a few leading examples of each ware. But as the Japan Society—newly formed since I undertook this paper—promises exhibitions of characteristic art productions, I hope that, before very long, an exhibition of Japanese keramic art wares may be arranged, which may afford more prolonged and complete studies of Japanese keramics than we can have to-night. Needless to say, too, that to any sympathetic lover or student of Japanese keramics it will always be a pleasure to me—as it is to every enthusiastic collector—to afford opportunities of the further study and examination of the pieces in my rather extensive collection.

Let us pass, then, to what is before us, and of course we must begin at the beginning. Yet of the true beginnings of Japanese pottery, of the prehistoric tomb and house pottery, of the dug-up specimens of sacrificial ware, of the earliest and rougher wares of the Cha-no-yu, in other words of purely archæological specimens, I have nothing to-night to say. You will find much about them in all the books, in the writings of Franks, of Ninagowa Noritani, and of Moise, and Bowes, and in the native handbooks. I have numerous specimens of them, and you will find them in the British Museum and South Kensington, the latter otherwise very ill supplied with the finer specimens of old Japanese keramic ware. But I do not propose, to-night, to speak to you of these earliest beginnings, or of this esoteric ware. I am dealing with what we may describe as the decorated art pottery and porcelain of old Japan, using those words in our European sense, and putting aside for the moment the traditions of the old Cha-jin.

I begin, then, here with the blue and white porcelain of Shonzui Gorodayu. It was in 1530 that Shonzui travelled to China to learn some of the secrets of the kilns of Foochow: he sojourned there for some years, and learned the art of mixing the pastes, of decorating with cobalts under the glaze, and *au grand feu*. It was in the best period of Chinese work, and he attained considerable skill. He returned to Arita (province of Hizen), bringing with him the materials as well as the secrets of the art; but as Japan did not at that time know of its own vast treasures of kaolin, he was sparing of his material, and he made only small specimens, for the most part with a diaper decoration. They are exceedingly scarce, but I have here three authentic specimens, one of them evidently made by him in

China. The small and choice specimen with pierced cover I secured at a private sale at Kyôtô—one of the most picturesque scenes that I can remember—in competition with a large company of the best connoisseurs of Japan, who all sat decorously in small coteries, or tea-parties, in screened compartments, squatting on their mats. We bid solemnly and decorously by writings dropped into a ballot-box, and when the ballot-boxes were opened, and the little pot was adjudged to me, Japanese politeness bid the attendants raise a hearty cheer, although some of them subsequently tried to tempt me to part with the little treasure, which they thought ought to be kept in a Japanese collection.

Imari or Hizen Porcelain, Decorated with Enamels over the Glaze.

Shonzui, says Brinkley, from whom I now begin my extracts, on his return from China, about 1516, settled at the village of Arita, in Hizen. The nearest port to Arita is Imari, a name familiar to all collectors as the common appellation of Japanese porcelain. After having exhausted the materials which he had brought with him from the Po-yang Lake, he failed to discover any suitable substitutes in Japan. Yet, strange to say, in the spur of the very hill which rose over the village where he lived, inexhaustible quantities of the much-desired clay were waiting to be used. His pupils and successors, Gorohachi and Goroshichi, were not more fortunate than himself, and the factory at Arita had almost lost the reputation acquired from his productions, when there arrived there one of the Korean experts, whom the Japanese generals had brought back from Korea by the Taiko's orders. This man's name was Risampei. Tradition says that in his own country he had acquired some reputation as a manufacturer of the celebrated "ivory-white," and the story sounds probable, for, had Risampei, like the great majority of Korean keramists, been familiar with the manufacture of pottery and faience only, it is most unlikely that he would have struck out an altogether novel line of his art in Japan. He had worked at Arita during two, or perhaps three, years, when, about 1599, he discovered on the slopes of Idzumiyama (the Mountain of Springs) a white substance that promised to supply the long-felt want. Resembling rather stone than clay, this *shiro-tsuchi* (white clay), as the Japanese commonly called it, had to be broken and pulverised in mills before the potter could employ it. It was in fact the *Petuntsu*, or feldspathic rock, of Chinese keramists.

Risampei's ware was known in the days of first manufacture as Kinko-yaki, Kinko being the name of his native place in Korea. I have said that the decoration of his pieces was limited to designs in blue under the glaze. The fact is that neither Risampei nor any other among the large number of Korean potters, brought to Japan by the Taiko's generals, could impart to their conquerors a knowledge of the methods of applying vitrifiable enamels over the glaze. It may be that the development of this process was checked by a comparatively trifling lack of information. The Japanese, already wonderfully skilful in other branches of technical art, would scarcely have been at a loss how to imitate the enamelled porcelain of China, had they not failed to perceive that, the vitrification of the enamels being effected at a much lower temperature than the baking of the *pâte*, the two operations must be conducted separately. But the Koreans, were they, too, ignorant of this? Among the numerous specimens of old Korean faience and porcelain preserved in Japanese collections, Captain Brinkley has seen only one decorated with coloured enamels over the glaze. This piece is attributed to the end of the sixteenth or beginning of the seventeenth century. It is certainly not less than 250 years old. But, if its existence seems to show that the manner of using vitrifiable enamels was not wholly unknown to the Korean keramists of Risampei's era, its unique character shows equally that such a process was altogether exceptional. Certainly, Risampei was not acquainted with the secret, nor did the potters of Arita learn it until nearly half a century after the Korean discovery of porcelain clay on Mount Idzumi. The honour of making this great addition to the keramic resources of his country is attributed to Higashidori Tokuzayemon. Like Toshiro and Shonzui, he seems to have contemplated a visit to China. With this view, it is said, he went from Arita to Nagasaki, in 1648, and there awaited an opportunity to carry out his purpose. Nagasaki was then a flourishing town of some six or seven and twenty thousand inhabitants. The Portuguese had been expelled eleven years before, but the Dutch had been settled in Deshima since 1641, and from seven to ten of their ships entered the harbour annually. It was with the Chinese junks, however, that Tokuzayemon had to do. These, too, came from time to time; and it so happened that

Tokuzayemon, explaining the purpose of his journey to a junk-master, learned from the latter the very few points which were needed for commencing the new style of decoration. He hastened back to Arita, and made his first essay with tolerable success. His chief idea appears to have been to imitate the Chinese enamelled wares of the Wanlieh period (1573-1619). But, as the attractions of these depended chiefly upon the brilliancy of their enamels, and as the Japanese potters lacked experience principally in this very branch of their art, no very satisfactory results were achieved. Among Tokuzayemon's fellow workmen, however, was one, Kakiyemon, who, fortunately, became impatient of imitative limits, and conceived the idea of adopting a line in better accord with his country's art instincts. The result was a chaste and very beautiful porcelain. Instead of loading his pieces with diapers and archaic designs in red and green enamels, Kakiyemon made the decorations a subordinate feature, and sought, bycareful conceptions, to compensate for what was lost in richness of effect. No one who has examined pieces decorated in this style which he inaugurated, will deny that his success was remarkable. The *pâte* of his ware was fine and pure, giving a clear, bell-like ring when struck. The milk-white glaze, charmingly soft, yet not lacking in brilliancy, formed a ground harmonizing excellently with the ornamentation, which was simple almost to severity. The enamels were clear and rich in tone, but of few colours: a lustreless red, a grass-green, and a lilac-blue constituting nearly the whole palette. Of the decorative subjects, floral medallions were, perhaps, most common; but the dragon, the *howo* (phœnix), the bamboo, the plum, the birds fluttering about a sheaf of corn, and various kinds of diapers were constantly depicted. The characteristics of this ware are not only the sparseness of the decoration, but also its distribution. Instead of being spread over the surface, the designs are confined to a few places, the object apparently being to surround each little picture with as ample a margin as possible.

Of the Kakiyemon type of Imari ware I am able to show you some very choice examples. This figure, from the Redleaf collection of Mr. Wells; this choice, delicately-enamelled and graceful figurine of Ousugumé, which is illustrated in Audsley's great book, and has been attributed by Japanese experts of eminence to Kakiyemon himself, but which Captain Brinkley considers to be of later date; and a series of plates and small bowls. They give a high opinion of the perfection of bare glaze and decoration which the artist potters of Imari had attained in the porcelain destined for their home use. I do not show you the Imari of exportation; the "old Japan ware" of our ancestors of the 18th and early 19th centuries; the "chrysanthemo-pæonian" ware of Jacquemart, the boast of the Dresden Museum still, and the pride of so many palaces and mansions. It is the existing type of the Imari ware of the cheap draper and grocer shop. Its violent decoration of violet, red, and gold was invented to please the European eye; it apparently does so still. It has little artistic value; it was estimable when it was unique. I could never see its beauty or appreciate its value. It is certainly not in the Japanese taste, and I leave it out of serious consideration.

Imari Blue and White Porcelain.

The decoration here described is that known as blue under the glaze. Blue, thus applied, enters into the decoration of all the enamelled porcelain produced in Hizen, with the exception of the wares of Kakiyemon and his imitators. The decoration with vitrifiable enamels was a process subsequent to the stoving of the glazed piece, and was, in fact, added to a vase which, without it, would have been a finished specimen of blue and white, as in this very early but well decorated and characteristic bottle. To vitrify and fix the enamels, another stoving was required. The Japanese were no great admirers of the deep and intense cobalt blue of the Chinese; nevertheless, the earlier Imari potters and artists followed Shonzui in adhering to the Chinese tradition of intensity of colour, and I show you some specimens of old Imari blue and white, which might well be Chinese of the period of Ming or Kien Lang.

Hirado Blue and White Porcelain.

The old Hirado porcelain shows, says Brinkley, the highest degree of perfection and excellence to which the keramist ever attained. The factory at Mikôchi-yama (written Mikawa-uchi-yama, or the "hill between the three rivers"), like that at Okôchi, was taken under special patronage. It appears that one at least of the potters who came to Japan in the train of Hideyoshi's generals settled at Mikôchi, about the year 1595, and inaugurated the manufacture of faience decorated with blue under the glaze.

No specimens of this ware are believed to be now extant. We may presume that it did not deserve preservation. Some twenty years later, the porcelain clay discovered by Risampei came into use at Mikôchi, but the method of applying vitrifiable enamels not being known, the only colour employed for decorative purposes was blue under the glaze. Probably for this reason the industry did not flourish, and the workshops had long been closed when, about the year 1740, Matsura, feudal chief of Hirado, an island off the coast of Hizen, caused them to be re-opened, and placed the workmen under strict supervision, forbidding them to sell or dispose of their productions without special permission. This nobleman appears to have been a very practical connoisseur. He bestowed scarcely less attention on the potteries of his fief than Louis XV. did on those of Sèvres. The pieces turned out were reserved entirely for his own use and that of his friends, or for presentation to the Court of the Tokugawa Regents in Yedo. I visited lately his descendant, Count Matsura, still living at Tokio. He has his private kilns in his garden. I saw the potter at work (and my wife sketched him) making presents for the Tsarewich, as in the olden time, and he favoured me with some pieces subsequently, which I highly value. To the ware potted at Mikôchi from this time (1740) until the period of Tempo (1830) must unquestionably be assigned the first place among the porcelains of Japan. It is called *Hirado-yaki.* The pâte, finer, purer and whiter than that of either *Nabeshima-yaki* or *Imari-yaki,* owed its exceptional qualities entirely to careful manipulation. On the trituration of the clay and its subsequent washing and straining, pains almost unlimited were bestowed, and the preparation of the glazing material was the work of months. Examined attentively, the *pâte* is found to be virtually free from the dark gritty particles so common in Imari ware, and the granulations in the surface of the glaze, invisible to the naked eye, are not more marked than in the best Chinese porcelain. It is not, however, till we consider the decoration that the incomparable beauties of this *Hirado-yaki* become fully apparent. With rare exceptions blue is the only colour employed. It is not the intense, fathomless colour of the old Chinese keramists, nor yet is it the light, bodiless blue of the Nabeshima ware. It is a colour between the two, exquisitely soft and clear, and harmonising perfectly with the milk-white, velvet-like glaze in which it seems to float. Of the execution of the designs it is impossible to speak too highly. Nothing approaching them can be found in the whole range of Chinese porcelains. One is puzzled to conceive, in the first place, how etching so wonderfully fine, and outlines of such detailed accuracy, can have been transferred to a surface of baked clay; and, in the second, how every process of glazing and stoving can have been effected with sufficient skill to preserve these delicate pictures. There are few subjects which the artists of Mikochi did not depict upon their pieces, and fewer still in which they fell short of marked success. No great number of many really choice specimens of *Hirado-yaki* have yet found their way westward. Only within the last few years did the passion for blue-and-white, suddenly developed in Europe, induce the Japanese virtuosi to place this ware upon the market, and the supply, always very limited, did not last long enough to familiarise American and European collectors with the merits of Japan's best porcelain.

The pure white porcelain of old Hirado is remarkable for its milky glaze; the modern commercial imitators are less perfect in material, have a greenish tint in the glaze, and are less perfect in the potting. Besides blue and white, the most characteristic colour used is brown. Of these chromatic Hirado pieces you have before you some noble pieces. You will notice the large covered bowl which has evidently served as a model for our old Bow and Plymouth ware, with shells and seaweed in relief. The figures, birds, flowers, and delicate reliefs of Hirado gave many hints to Dresden. Of these original models, I have placed some exquisite and important specimens, selected out of many in my possession, on the table.

The Nabeshima ware, made at the Okôchi-yama kilns, under the patronage of Nabeshima, feudal chief of Hizen, are not less remarkable for their perfection of blue and white decoration and of paste than those of Hirado. They have generally, also, a characteristic combination of red introduced. The Nabeshima potters, as a rule, did not use marks, and never copied Chinese marks except on pieces which were obvious reproductions of Chinese originals. The reason of this is easily understood when we remember that the productions of the Okôchi factories were destined solely for the House of Nabeshima. Okôchi, in fact, was a private kiln. There was no occasion to mark porcelains manufactured there as though they were intended for general sale. With the rare exception of an occasional ideograph,

Nabeshima-yaki may be said to be without marks or seals of any description. Nabeshima ware was not a mercantile product, and seldom comes now into the market. I show you a few specimens of it, but I have seen few specimens of the original ware for sale over in Japan.

Satsuma Faience.

Whatever title to keramic celebrity Japan may found upon her porcelain, it is probably for her pottery that she will be longest spoken of. For while, says Brinkley, her porcelain manufacturers—those of Hirado excepted—were always more or less subservient to the fashions of Chinese originals, her workers in pottery and faience gave untrammeled play to their native genius, and, both in shapes and styles of decoration, produced pieces of the greatest beauty and quaintness. Among all the faïences of Japan, western amateurs have agreed to assign the first place to the well-known Satsuma-yaki. One may safely say, says Brinkley, that no European and American collection is deemed complete unless it contains a piece of the ware; and to this I am disposed to add—though few will be disposed to believe it—that Western collectors rarely possess a really representative specimen. It may not be denied that pottery of a brilliantly decorative and at the same time artistic, nature has been exported in considerable quantities to Europe and America during the past ten years, under the name of old Satsuma, but there need be no hesitation in asserting that in many and most essential respects, this showy ware differs completely from the beautiful faience so highly prized by Japanese connoisseurs. If it be admitted that first-class specimens of ancient Chinese celadon bear some comparison with the jade which they were designed to imitate, there will be no risk of hyperbole in asserting that the satsuma ware of bygone times can scarcely at first sight be distinguished from ivory.

In 1598 the celebrated Shimazu Yoshihiro, chieftain of Satsuma, returning from the invasion of Korea, brought with him a large number of workmen, some five score it is said, of whom seventeeen were skilled potters. They were settled at first in three villages, Kushikino, Tchiku, and Sanno-gawa; but, subsequently, a few of the most skilled of them were removed to Chôsa, in the neighbouring province of Osumi, where their patron, Yoshihiro, had one of his castles. Here, ware of various sorts was produced, some copied directly from Korean models, some covered with glaze of various colours—green, yellow, or black—and some of a flambé description. The paste was fine, and well manipulated, and of a greyish-red colour; but the chief beauty of the ware, or, rather, of the parti-coloured and flambé varieties, was the glaze, of which two, three, and sometimes four coats were applied, as in the bowl on the table, until effects of considerable richness and diversity were obtained. A potter, called Saburohei, was especially renowned in this matter of glaze. His pieces bear no mark, but connoisseurs profess ability to distinguish them at once, by their excellence of shape and lustrous surface. Here is a specimen attributed to Saburohei, and here a much more modern reproduction, but still one of great beauty and richness of glaze.

About the year 1670, Mitsuhisa, then chief of Sasshiu, caused a kiln to be set up in the grounds of his own castle, and the workmen employed there were familiar with the use of vitrifiable enamels. Iyemitsu, third regent of the Tokugawa dynasty, had encouraged the already growing taste for highly-decorated ware, and his influence was felt at all the centres of keramic industry in Japan. The Prince of Sasshiu, having established a factory, invited thither the painter Tangen, pupil of the renowned Tanyu and commissioned him either to paint faience himself, or to furnish the workmen with designs. The outcome of this factory was necessarily small, the pieces being destined entirely for private use or for presents. But that enamelled faience was produced there, and that beautiful specimens, known to this day as "Satsuma-Tangen," from the name of the artist engaged in their decoration, are amongst the treasures of Japanese collectors, there is no valid reason to doubt. The point to be observed is, that this fashion of decoration did not, at that time, extend to any other factory in the province. Thus, when the successors of Prince Mitsuhisa ceased to patronise the art, and when the private kiln established by the noblemen was closed, a considerable period elapsed before the potters of Satsuma thought of studying processes which no longer received the encouragement of the lords of the district. At the end of the 18th century, however, Mari Akihira (afterwards called Yeiô), Chief of Sasshiu, took the factory at Satsuma under his protection. It was at his instance that the two workmen, Kin and Kuw-abara, visited Kyôtô; and it is to his patronage that we

owe the renaissance, afterwards erroneously described as the origin of Satsuma enamelled faïence.

The distinguishing feature of the specimens produced in the time of Yeiô, as well as in the early days of the manufactures, was the fineness of the *pâte*. It was as close-grained as pipe-clay, and almost as hard as porcelain biscuit. The Satsuma potter confined himself strictly to diapers, floral subjects, landscapes, and a few conventionalities, such as the Howo, the Shishi (mythical lion), the Dragon and the Kirin (unicorn).

Although the faience of Satsuma is known to Western collectors chiefly for the sake of its enamelled pieces, its monochrome and flambé glazes also deserve mention. Of the former, yellow and black are the most remarkable, but both are exceedingly rare. Another monochrome glaze, which may almost be called a speciality of the Satsuma potters, is olive green. This colour, however, is seldom employed alone, being generally associated with a peculiar dark mustard yellow, or a chocolate brown. Such glazes as these are, for the most part, confined to tea jars, incense boxes, and other utensils for use at Cha-no-Yu ceremonials. Neither is the *pâte* of pieces thus decorated made of the well-known white earth, but of an exceedingly fine iron-red pipe-clay, which the amateur easily learns to recognize after he has seen one or two specimens. Another infallible guide in identifying a Satsuma tea jar (chatsubo) is the ito-giri, a mark left on the bottom by the thread with which the potter used to sever the piece from the clay out of which it was modelled. This mark is found upon all carefully manufactured Japanese tea jars; but since the Korean workmen, who settled in Satsuma, turned the throwing-wheel with the left foot, while potters at other factories turned it with the right, it will be readily understood that the spiral of the Satsuma thread-mark is from left to right, and that of other factories from right to left. Pure white faience, sometimes cleverly moulded or reticulated, was a favourite production of the ancient Satsuma potters.

In illustration of the varieties thus succinctly described by Brinkley, let me show now specimens—(1) of the flambé ware of Satsuma, this tall jar of tiger-skin glaze; (2) specimens, of which I have many, of the white, or, as the American connoisseurs call it, from its subtle undertints, the "mushroom," or undecorated crackle, of which the rarest are this bottle with white raised hawthorn, this figure of the boy and fan, and this okimono of Fusyama, with clouds at its base, and the figure of Fukurokuju; (3) the rare specimens of black satsuma, of yellow satsuma, and of satsuma-Tangen, decorated with freehand drawing; (4) this Chinese boy (Karako) with brocaded robes; and (5) an unrivalled example of the ivory ware in this very fine figure of Hotei. I do not need to say a word about any of these specimens. They speak for themselves. In acquiring the collections of Maizan, and the choice specimens of Wakai and Hayashi Sohichi, I was able, at a stroke, to secure a series which I had never hoped to obtain. For, during the whole of my stay in Japan, in private and public collections, and in all the collections which I have seen in Europe, fine Satsuma of the older dates is the rarest and least attainable, while spurious imitations are the most abundant and disfiguring features. But of some thousands of pieces of so-called Satsuma offered me elsewhere, and at other times, I have hardly ever found one that was both genuine and of any art value.

Faience of Kyôtô and Environs.—Specimens by Nomura Ninsei.

With Nomura Seisuke (called also Seiyemon and Sebei) the real history of the famous Kyôtô faience commences. There is no name more renowned in the catalogue of Japanese Keramists. His native place was a village near the shrine of Ninwaji (pronounced Ninnaji) in the environs of Kyôtô, and by combining the initial syllables of this word with that of his name (Seisuke) there was obtained the term "Ninsei," by which the man and his works are known to posterity.

It will be remembered that the methods of decoration with vitrifiable enamels was acquired by Tokuzayemon, of Arita, in 1648. Naturally a considerable quantity of the new ware found its way to the capital, where it excited at once the admiration and envy of the leading keramists. But for a time the possibility of imitating it does not seem to have been conceived, since the secret was guarded at the Hizen factories by a series of the most rigorous enactments. It happened, however, that, between the years 1650 and 1654, a certain Aoyama Koyemon, acting as agent for the sale of the new porcelain, associated himself with one Kuhei, a faïence vendor of Kyôtô, and was persuaded by the latter, who seems to have been gifted with no small amount of tact and craft, to disclose the

methods which had won for Arita so valuable a monopoly. The unfortunate Koyemon's indiscretion is said to have cost him his life, but the precious recipe remained in Kuhei's possession, and subsequently passed into the hands of Nomura Ninsei. We may, therefore, with very little risk of inaccuracy, ascribe the first manufacture of enamelled faience in Japan to the year 1653.

Not having made keramics his profession, Ninsei had no fixed workship. His first productions were potted in the neighbourhood of the temple of Seikan, and at a kiln called Otowa, both of which are in the district of Omuro. Hence the origin of the term *Omuro-yaki*, by which these pieces are generally known. Subsequently he worked at the factories of Awata, Iwakura, and Mizoro, not only practising but imparting the secrets he had acquired. All these places are in or near Kyôto.

If Ninsei's title to fame rested solely upon the fact that he was the originator of enamelled faience, he would deserve to be remembered. For, though he did not invent these processes, his manner of employing them marked an epoch in the history of his country's keramics. Under his inspiration the wares of Kyoto assumed a new character. He was the first to shake himself free from alien influences, whether Chinese or Korean, and to adopt the "natural style" now universally regarded as representative of Japan.

In Ninsei's hands, the faience of Kyôtô became an object of rare beauty. Not only was the *pâte* of his pieces close and hard, but the crackle of the buff, or cream-coloured glaze, was almost as regular as the spider's web. Only the most painstaking manipulation of materials and management of temperature in stoving could have accomplished such results. In later and less conscientious times, the nature of the crackle changed so perceptibly, that this one point affords a trustworthy criterion of old and fine ware. Ninsei's crackle was nearly circular. The surface of choice specimens of his handiwork conveys the impression of being covered with very fine netting, rather than with a tracery of interesting lines. Its appearance is aptly described by the Chinese term "fish-roe crackle." Working, as he did, at different places, varieties are found in the *pâte* of his pieces. The most common is a hard, close-grained clay, verging upon brick-red in colour, and perfectly free from foreign particles. Sometimes the colour changes to a yellowish grey, and the texture becomes nearly as fine as that of pipe-clay. His monochrome glazes are less remarkable than his crackle. First among them must be placed a metallic black, run over a grass-green in such a way that the latter shows just sufficiently to correct any sombreness of effect. On the surface of this glaze, or else in reserved medallions of cream-like crackle, are painted diapers, and chaste floral designs in gold, silver, red, and coloured enamels. Another glaze invented by him, and imitated successfully by the chief experts among his successors, is a pearl-white, through which a pink blush seems to spread. In golden brown, chocolate, and buff he also produced charming tints, and his skill as a modeller was scarcely less than his mastery of mechanical details. As a rule he marked his pieces with the two ideographs Ninsei engraved in the paste.

Genuine specimens of his ware are very scarce. They do exist, and find their way into the market from time to time, but their high value in Japan—as much as two or three hundred dollars, are readily paid for a small bowl of the best description—effectually keeps them out of Western collections. If it were required to indicate tests of easy application for determining the claims of a piece attributed to Ninsei, we should name, first the *pâte*, which ought to be very hard, and of brick-red or yellowish gray colour; and, secondly, the crackle, which should be uniform and of circular shape. On Ninsei's great contemporary, the painter Tanyu, it cannot be denied that he deserved a considerable part of the fame which fell to his lot. The famous artist and the great keramist appear to have been fast friends. It is related that they took an equal interest in each other's art, and that many of the pieces manufactured by Ninsei bore designs from the brush of Tanyû or his pupil Yeishin. These designs were largely imitated at the Kyôtô factories, and the popularity of pieces thus decorated was shared by specimens copied from Chinese ware ornamented with fishes from the brush of a Chinese artist, Bokkei, and hence called *Bokkei-bachi*. In fact, public taste turned completely from the sober and severe style of the Seto potters. Decorated faience became the rage, and in some quarters of Kyôtô every second house had its little workshop and kiln. I would name to you, as peculiarly fine and authentic specimens of Ninsei's work before you, the crab, the letter-press shaped as a kakemono, the tall bottle decorated with flowers,

and some of the smaller pieces which I put before, out of many which have at various times been sent me from Japan.

Awata Faience.

Under Ninsei's influence, however, the industry attained such dimensions, that particular kilns began to be spoken of. Amongst these, the most important is that of Awata. It was established about the year 1620 by an artist, called Kuzayemon, of whose origin and early history we have no record. At first, his productions attracted little attention, but, by and by, he began to copy Ninsei's methods, decorating his pieces with black and blue pigments, and, ultimately, with coloured enamels. Ninsei himself visited the Awata factory, and manufactured many good specimens there, although the materials which the district afforded were not of the choicest. The *pâte*, indeed, of the Awata-yaki was close, pure, and hard in those early days; but its glaze was not pleasing, being generally of a greyish white, semi-translucid, and lacking the soft yet rich tone which is justly so much admdier in fine specimens of Japanese faïence. The crackle was uniform, and tolerably small, but frequently its too palpable edges imparted to the whole surface a slightly crude aspect. Probably, for this reason, the Awata potters soon fell into the habit of decorating their pieces more profusely than those of other factories. Early in the 18th century, however, a workman whose artist-name was Kinkôzan, effected signal improvements in the Awata ware. Under his treatment the glaze lost its imperfections, and assumed a creamy lustrous tone, which formed a beautiful ground for the enamels. Among the latter the two principal were grass-green and ultra-marine. Red was also used, and gold is found almost invariably, its rich sheen harmonising excellently with the soft buff colour of the glaze. Silver, purple, and yellow are rare. Some specimens of *Awata-yaki* are marked with the ideographs, *Awa-ta*; others are marked *Kinkô-zan*; but the majority are not thus distinguished. In determining the age of a piece of this faïence, three rules, equally applicable to all the wares of Kyôtô, may be laid down; first, the *pâte* of choice old specimens is close and hard; secondly, the glaze is lustrous, and the crackle fine and uniform; thirdly, the enamels are clear, brilliant, and carefully applied. It may generally be assumed that the degree in which these qualities are present varies directly as the age of a piece, always remembering, however, that when judging Awata faïence, an exception must be made in respect of specimens manufactured before the time of Kinkô-zan (*i.e.*, during the 17th century), for these, while fully satisfying the first and third of the above conditions, usually fail with regard to the second.

Kenzan Ware (Faience).

The history of the keramics of Kyôtô is a record of individuals, not factories. Ninsei's figure overshadows all the rest, and next to him, at no great distance in some respects, comes Ogata Sansei, commonly called Kenzan, Ogata was born at Narutaki-mura, in the suburbs of Kyôtô, in the year 1660; that is to say, just at the time when the methods introduced by Ninsei and Wanjin had fairly won their way to public favour. He was the second son of Ogata Soken, and his younger brother was the celebrated painter Korin. Sansei, who appears to have been called also Shinsei and Shinsaburo, was himself a painter of considerable promise, but his proclivities, fortunately, lay in the direction of keramics. After he had studied literature and poesy under the well-remembered Hirosawa Nagayoshi, and the mysteries of *Cha-no-Yu* under Zuiriu Sosa, whom the men of the next generation elevated into a semi-divinity, under the title of Nichiren Sosa, he spent a short time in the practice of his father's favourite art, and his pictures are said to have given earnest of great talent. That he preferred to devote his brush to the ornamentation of faïence was partly, perhaps, because the designs furnished for that purpose by Tanyu and Yeishin had attracted so much attention, and partly because his brother Korin, in whom he must have recognised a greater artist than himself, had already developed a taste for lacquer decoration. At first he appears to have applied himself diligently to the study of technical processes, taking for his instructors the potters of Raku, Seto, and Zeze. Very soon, however, he developed an original style, of which the chief characterists are great boldness, combined with a very skilful disposition of tints, both in the execution of designs and in surface decoration. Kenzan is, in fact, a perfect representative of the genuine Japanese school, which requires that results, however elaborate, shall convey no idea of detailed effort, and enforces strict obedience to the natural principle of limited impressions. A branch of plum blossoms, a tuft of feathery

reeds and bending grasses, a family of sparrows clustering amid the foliage of a bamboo, or the blue crest of a mountain peeping through a haze of golden clouds—such things as these can be comprehended at a single glance, and are, therefore, legitimate subjects for representation in the circumscribed field which the artist has at his disposal. Kenzan thoroughly understood this. His designs are often exceedingly artistic for all their simplicity, and the landscapes depicted on some of his smaller pieces embody most graceful conceptions. He preferred *Shibu-ye* and *Ai-ye*—designs in black, russet-brown, and blue—to *Kin-ye*—designs in coloured enamels and gold. But in all three varieties of decoration he showed himself equally a master. His best pieces were potted at Awata, and neither their *pâte* nor their glaze is distinguishable from that of the ordinary *Awata-yaki*; the style, however, cannot possibly be mistaken. A further guide is the cachet. Kenzan marked all his pieces with his name, "Kenzan." Sometimes he used clay from other localities, especially that ftom Shigaraki (*vide* "Shigaraki-yaki), which produced a coarse, gritty *pâte*, far inferior to the *Awata-yaki*, but well adapted to the exceptionally bold outline-sketches which, with true artistic instinct, he invariably employed in the ornamentation of these rougher specimens. At a late period of his career we find him working at Iriya, in Yedo (now Tôkyô), but the materials procurable in the neighbourhood of the eastern capital were of such inferior quality, that even Kenzan could produce nothing satisfactory with them. Urged rather by love for his craft than desire of gain, he never attempted to manufacture large quantities of faïence, so that genuine specimens of his work are exceedingly rare, and proportionately valued. His style was, however, copied with considerable fidelity and success by his son and grandson, whose pieces, marked with the same cachet, "Kenzan," only differ from those of Ogata himself in being slightly inferior both in *technique* and artistic qualities.

Here are some characteristic specimens of the different styles of Kenzan, all of them marked with his cachet; plateaux-coupés and perfume-boxes, some of them from designs by his brother, Korin, and therefore having a double interest. They are so characteristic in their bold and sketchy impressionism that they form a school by themselves, and once seen are easily recognised.

EIRAKU WARE.

I show you, without entering into details, some remarkable specimens of the work of Mokubei, a great potter, whose history I reserve for another occasion. The processes which Mokubei had originated were, says Brinkley, extended and perfected by Zengoro-Hozen, commonly called Eiraku. This man's speciality was the manufacture of urns (*furo*) for the *Chajin*. His factory was at Nara, and he enjoyed the patronage of the renowned dilettanti Shukô and Jô-ô. After his death (1558), his son, Nishimura Sôzen, moved to Sakai, in Senshû; and Sozen's son, of the same name, transferred his residence, in 1594, to Shim-kyô-roku-jô, in Kyôtô, from whence one more move to Anraku-koji brought the family to the house it occupied until nearly the middle of the present century. The representative of the eleventh generation was Zengoro-Hozen. At first, content to follow the route trodden by his ancestors, he confined himself to the production of unglazed urns for the use of the tea clubs. Even in this work the remarkable dexterity with which he blended *pâtes* of different colours gave earnest of greater achievements in other branches of the keramic art. This promise was soon fulfilled. Practising porcelain manufacture as a species of pastime in the intervals of his regular trade, he ultimately developed such skill that his celadons and pieces, decorated with blue under the glaze, attracted wide attention. To these he soon added admirable imitations of the old Cochin-Chinese faïences. The conditions of the time were especially favourable. Long continued peace had filled the coffers o[f] the nobles, and induced those luxurious ha[bits] of life among which art products find th[e] best market. The Court at Yedo, preside[d] over by Iyenari, eleventh prince of the Toku-gawa dynasty, set an example of brilliant extravagance, to which the feudal princes were nothing loth to conform, while the now well-established custom of sending to the Shogun yearly presents of pottery and porcelain from the various districts, had engendered a wholesome rivalry among the provincial factories. Before long, Zengoro's fame attracted the attention of Harunori, Lord of Kish[iu]. He invited the potter (A.D. 1827) to his pr[o]vince, and there set up for him, within the [pr]ecints of the castle park, a kiln, at which w[a]s produced the celebrated *Oniwa-yaki*, or *E[i]raku* ware, as it is also called, from the s[ta]mp it bears. It was an imitation of the [C]hinese faïence, but, in purity of colour, it [sc]arcely

equalled its original. Like Luca della Robbia, Zenguro made the composition and application of glazes an especial study. We search the works of his successors and predecessors in vain for examples of parallel perfection in this branch of keramics. His Aubergine porcelain, and the rich combinations of turquoise blue, purple, and yellow shown in the glazes of his faïence, amply justify the immense popularity attained by the Yeiraku ware. A prominent place among his achievements belongs to his *Kinrande* or *Akaji:kinga*, which bears the stamp *Eiraku*. The idea of this porcelain was derived from the much-valued Chinese "rouge vif" of the *Yung-lo* period (1403-25), and the Japanese potter succeeded in producing a colour little inferior to that of the original. In fact, his coral-red glaze, lustrous and, at the same time, exquisitely soft, with its wealth of golden decoration and reserved medallions in brilliant cobalt, must be classed among the keramic masterpieces, not of Japan alone, but of the whole world. These terms *Kinrande* (scarlet and gold brocade pattern) and *Akaji: kinga* (golden designs on a red ground), are descriptive. The stamp *Eiraku* was suggested by the Japanese pronunciation of the Chinese period-name, *Yung-lo.* The Chief of Kishu also bestowed upon Zengoro another seal, inscribed with the ideographs, *Ka hin Shirui.* This seal Zengoro appears to have used to mark his choicest pieces only; a distinction which accords with the material of which the two seals were made, that bearing the characters of *Eiraku* being of silver, and that bearing the characters *Kahin-Shiriu* of gold. rom the time of his visit to Kishu the potter's e rapidly augmented. It became the fashion h the magnates of the western capital to ve him orders, and their amusement to test is skill by asking him to copy *chef d'œuvre* of Chinese, Korean, and even Dutch manufacture, which had been handed down in their families for generations. Zengoro's success in these trials of skill is said to have been remarkable. It is recorded that a tea-urn, secretly borrowed by a court noble called Takatsukasa from the custodians of the Kono-e heirlooms, was so perfectly imitated at the Eiraku workshop, that the original and the imitatin were not distinguishable. This feat procurd for Zengoro another seal bearing the inscripbn *Tokin-ken* (the weighty potter); a mark wich is not found upon his wares. From Prince risugawa he also received a document conferr-g the title of *Ito-seimei* (the world-renowné keramist). Opulent and respected, Zengoro might now have passed the remainder of his days in repose and comfort. But his heart was in his art. Like Bernard Palissy, the successful production of a new glaze was to him almost a matter of life and death. He had mastered the processes required to produce the purple, yellow, turquoise, and green faïence of Cochin China, the blue and white, coral-red, and enamelled porcelains of China. Two things only he could not copy—the stanniferous glaze of the Delft faïence, and the transmutation glazes of the Po-yang lake. To the investigation of these he employed himself diligently, gradually spending upon fruitless experiments the money he had accumulated by his previous works.

I show you specimens of the various styles of Zingoro; his brilliant coral and gold, his red-violet, his various and polychromatic kogas. You will recognise the perfection of the technique, and the purity and intensity of the colour.

Kutani Ware.

After the wares of Hizen, Kyôtô, and Satsuma, there is none better known, outside Japan, than the *Kutani-yaki*. The origin of the factory is attributed to Mayeda Toshiharu, lord of Taichoji, in the province of Kaga, who who caused a kiln to be built at the village of Kutani, and placed it under the direction of his vassal, Tamura Gonzayemon. The exact date of this event is not known, but it certainly lies between the years 1635 and 1660. It does not appear that any keramic industry had existed in Kaga before that time—a condition which probably resulted from the comparatively isolated position of the province, lying, as it does, on the extreme west of Japan, and being separated by a lofty range of mountains from Kyôtô, the centre of luxury and art-patronage. The productions of the new kiln were after the fashion of the old Seto ware; that is to say, tea-jars and water-vessels of dark clay, covered with a light chocolate glaze. In 1665, however, Toshiharu's son, Toshiaki, anxious to develop the so far unpromising enterprise which his father had inaugurated, sent one Goto Saijiro to Hizen, for the purpose of acquiring the methods of porcelain manufacture. On his return, the nature of the *Kutani-yaki* underwent a complete change.

Yet there is nothing at all perplexing or doubtful about the history of the Kutani factories. During the 17th and early part of the 18th century, the wares produced there were of two sorts. The first, and more

characteristic, was the *Ao-Kutani*, so called from a deep green (*ao*) glaze, of great brilliancy and beauty, which was largely used in its decoration. Associated with this glaze were others, not less lustrous and full-toned, yellow, purple, and sometimes a soft Prussian blue. These glazes were laid on so as to form diapers, scrolls, and floral designs; or they were simply run over designs traced in black on the biscuit. That the decoration must be regarded as, and was, indeed, confessed to be, an imitation of that attributed to the potters of Cochin China in their *Kôchi-yaki*. The second class of ware was decorated somewhat after the Arita fashion, with this principal difference, that the Kutani potters never, so far as we know, employed blue under the glaze in conjunction with enamels. Their chief colours were green and red, supplemented by purple, yellow, blue (enamel), and gold. Red was a speciality. They produced a peculiarly soft, subdued, full-bodied colour, varying from a rich Indian-red to a russet-brown. For designs, the early potters had recourse to a well-known artist, Kuzumi Morikage, of the Kano school, who loved to depict miniature landscapes, flowers ruffled by the breeze, sparrows perched among plum-branches, and other glimpses of nature in her simplest garb. We never find anything resembling that wealth of brilliant blossoms and massing of bold colours by which the porcelain of Arita was distinguished. The keramists of Kaga were always faithful to the fashions inaugurated by Morikage. On many of their best productions the decoration is of a purely formal character, diapers, scrolls, and medallions, containing conventional symbols. The only figure-subjects met with are the Chinese *Karako*, or children at play. As with the faïence of Satsuma, so with the ware of Kutani, the amateur may be quite sure that specimens decorated with peacocks, groups of chrysanthemums and peonies, figures of wrinkled saints or brightly draped ladies, cocks upon drums, and so forth, belong to the manufactures of modern times.

So far we have spoken of the style of decoration only. The *pâte* remains to be considered. Here a difficulty presents itself. The potters of Kutani originally took their clay from a hill near the village of Azayatsu. It was not porcelain earth; it was not even capable of being manufactured into good pottery. Thus we find that some of the oldest pieces of this ware are technically very faulty. But these pieces do not belong to either of the classes mentioned above. The incongruity of applying lustrous glazes or rich enamels to a radically defective *pâte* was recognised at once, and the Kutani artists, baffled by the refractory nature of their local materials, imported good clay from Hizen, or any other convenient place. Sometimes they used this imported clay only; sometimes they eked it out by an admixture of earth procurable on the spot; sometimes they even went so far as to apply their own decorative processes and marks to biscuit manufactured elsewhere. There resulted a considerable source of perplexity for the amateur. Among specimens of the old *Ao-Kutani* he will find stone-ware and porcelain; while, on the other hand, pieces decorated after the fashions inaugurated by Kuzumi Morikage are, with very rare exceptions, excellent porcelain. We have seen pieces of *Kutani-yaki*, dating as far back as the beginning of the eighteenth century, which would bear comparison with the best Hizen egg-shell. It has to be confessed, therefore, that among all the wares of Japan, the *Kutani-yaki* alone offers a *pâte* as likely to mislead as to instruct. This is especially true of blue and white specimens. We have said that, so far as we know, or have been able to ascertain from Japanese experts, *blue sous couverte* is never found upon old Kutani ware in conjunction with enamelled decoration. But pieces decorated with blue only, though rare, are occasionally met with. In these, the connoiseur's only guides will generally be the nature of the glaze and the tone of the blue. The latter lacks the depth and richness of the best Hizen blues, and is equally removed from the delica purity of the Hirado colour; it is, in fact, inferior, somewhat impure, pigment. Thi however, is obviously an uncertain criterion the glaze is more trustworthy. It shows a peculiar waxy softness, which generally suffices to establish a distinction. But, in truth, specimens of blue and white kutani are so very exceptional, that we need scarcely dwell upon their characteristics. In the case of polychrome pieces, the richness and lustre of the enamels, their full, clear colours, and the severity of the decorative style, constitute features easily identifiable. Above all, the beauty of the glaze is incomparable. In choice specimens, its tone almost equals that of the celebrated ivory-white of China.

You can judge, from the specimens on the table, the justice of Captain Brinkley's eulogy. The tall-necked bottle and the censer, in its

pierced silver cover, are perfectly typical specimens of the most characteristic styles; while this white jar, with Chinese figures in coloured enamel, shows how close they came to the Chinese originals in that style. I bought it in China, and but for its seal, it would pass for Ming ware.

KISHU WARE.—ONIWA-YAKI, OR KAIRAKU-YEN-YAKI.

A little more than half a mile westward of Wakayama, in the province of Kishû, stood formerly the country residence of the family whose representatives governed the district. Within the park of this Nishihama, at the beginning of the present century, Tokugawa Harunori, then head of the family, caused a private kiln to be built for the manufacture of porcelain decorated with blue under the glaze. We have seen that the porcelain industry, as distinguished from that of pottery and faïence, received a notable impulse in the opening years of the 19th century. The Nishihama factory is an example of this development. Very little is known of its first productions. They were completely lost sight of when, in 1827, Harunori, after one of his periodical visits to Kyôtô, brought back with him the already renowned keramist, Zengoro Hozen. The character of the Kishû-yaki immediately underwent a complete change. Zengoro had made his name by imitating the brilliant glazes of Cochin-China, and to this species of work he applied himself at Harunori's factory. The outcome of the kiln was thenceforth known as *O-niwa-yaki* (ware of the honourable park) or *Kairaku-yen-ki* (ware of the park of ease and fellowship). The *pâte*, sometimes white, sometimes reddish gray, was very fine, varying from porcelain to faïence, but being for the most part a hard stoneware. The glazes were remarkably rich and beautiful: purple, green, turquoise, yellow and white. They were employed in various ways. Perhaps the most common was a purple ground covered with scroll-work in relief, portions of the scroll being filled with turquoise blue. In other and more excellent pieces we find a rich green mould marbled with purple, or decorated with medallions in yellow, purple, white and blue. Glazes showing greater richness, lustre, and purity colour were never produced by any Japanese potter. Harunori loaded Zengoro with favours, and bestowed on him three seals: two of silver, bearing the inscriptions *Kairakuyen* and *Eiraku*, and one of gold, inscribed *Kahin Shiriu*. Japanese antiquaries say that the term *Kahin Shiriu* (branch of *Kahin*) has reference to the earliest pottery of China, which, according to them, was manufactured by an artist called Chun, at the kiln of Kahin (Chinese *Hopin*), about 4,000 years ago. This point is involved in obscurity. Eiraku, as we have already explained, is the Japanese pronunciation of the Chinese period *Yung-lo* (1403-1425), during which was first produced the celebrated "rouge vif," with decorations in gold. Zengoro never allowed any specimen to leave his hands bearing the stamp *Kahin Shiriu* unless he was thoroughly satisfied with the success of his work. Sometimes he added the mark *Eiraku*, and in many cases his imitations of the Chinese turquoise-blues and purples are stamped simply "*Kairaku-yen*. He generally worked to order, and it is said to have been his habit to manufacture from five to ten specimens of any piece which he had undertaken to produce. Of these, the best was chosen, and the remainder were destroyed in the presence of the person who had ordered them. He appears to have remained some eight or nine years in Kishu, and after his return to Kyôtô, the Nishihama factory was placed under the direction of another workman from the western capital, by name Yoshehei. It would appear, however, that Zengoro's glazes were not to be compassed by any other expert. The Kairaku ware gradually lost its high character, and on Harunori's death, in 1844, the manufacture came to an end.

This Kishiu bottle, is, I think you will say, quite equal to the finest Chinese ware in colouring and glaze, and is a very good example, together with others of the products of the best periods of the Kishiu kiln. I bought it in Kioto, from a collector who prized it as his best piece, but who had another somewhat larger, and was willing to part with this.

IMBE, OR BIZEN (STONEWARE).

The *Imbe* ware was produced at a place of the same name, in the province of Bizen. Pottery was made, no doubt, in this district at a very early date, but does not seem to have attracted any attention before the end of the 15th century. Even then, too, it was of the coarsest description, its gritty red *pâte* and unglazed surface fitting it for the manufacture of only the commonest utensils. From Hideyoshi's time (1580), a considerable improvement became visible. The clay was manipulated with greater care, and some of the specimens are compared by connoisseurs to

the Chinese boccaro, which they were, no doubt, intended to imitate. The most valued pieces of this, *Kok-bizen* (old bizen), are those stamped with the shape of a new moon (*Mikazuki*), a waning moon (*Kayezuki*), or the characters *Kokubei;* while another slightly inferior variety bears the delineation of a cherry blossom. Originally, the terms *Bizen-yaki* and *Imbe-yaki* were interchangeable, but by degrees the former came to be applied to the unglazed, the latter, to the glazed specimens; while a third term, *Hidasuki*, was introduced to describe a variety in which the surface is marbled by irregular patches or lines of red. A tolerable idea of the pottery's qualifications, as well as of the Tea Clubs' proclivities, may be formed from the fact, that this marbled effect is obtained by tying straw ropes round the pieces before placing it in the oven; and that an approved specimen of the rough unglazed result—which resembles nothing more than a half-baked brick—easily finds a purchaser to-day at from 50 to 100 dollars.

This criticism applies only to the Bizen pottery of old times. Towards the close of the 17th century, the character of the ware underwent marked improvement. A slate-coloured or a brown *pâte*, fine as pipe-clay and almost as hard as porcelain, was used to model figures of deities, genii, birds, fishes, aud mythical animals. It is scarcely possible to speak in too high terms of the plastic ability thenceforth developed by the Bizen potters. Their best efforts are admirably faithful, and will bear comparison with similar work produced in any country and at any age. A little later they used a red clay giving a *pâte* scarcely less fine and hard than of the *Ao-Bizen*, as the former variety is called. The glaze applied to this red *pâte* is peculiar to Bizen. Its colour and metallic sheen give it exactly the appearance of the beautiful *Sentoku*, or golden bronze. Those who have seen choice specimens of this middle period Bezen stoneware cannot hesitate to class it among the very highest achievements of Japanese art. As for the Bizen pottery of our own time, we need only say that it has shared the general degeneracy of its fellows. The red-clay figures of obese deities and unreal monsters that now-a-days stand in every *bric-à-brac* shop, may possess some attraction borrowed from the traditions they recall, but cannot be counted types of either cunning craft or praiseworthy art.

The finest old Bizen, in brown salt glaze, and in the still rarer grey and white varieties, are quite worthy of the highest eulogy. This little okimono in wood ware, and this group of birds, this cock, and brick, I have selected as examples. The white Bizen is rarest of all. The bird on a stump and the hotsei on the table are specimens of which I know no equals. It is hardly to be found now in Japan. I was asked an exorbitant price for a broken piece—an owl in Osaka—and I hesitated, but when I made up my mind to have it, it was gone to a private collector. There is a modern imitation of it, and of the grey Bizen, which is known by the softness of its added glaze, and by its dull sound, and imperfectly baked vase. The old Bizen was left for many days, and even weeks, it is said, in the kiln, so that the glaze is thoroughly incorporated into the vase—burnt into it as one body — and it has a hard, metallic ring. There is no more thoroughly characteristic ware of old Japan.

Higo Ware (called also Yatsushiro or Udo Ware). (Faience.)

The principal province of Kiushiu is Higo, which lies to the south of Hizen. The feudal chief of this province, at the end of the sixteenth century, was the renowned warrior, Kato Kiyomasa, who led the expedition of 159z to Korea. Returning in 1598, he brought with him a Korean potter, who had previously exercised his trade at Pusan. This man's name was Sonkai (Japanese pronunciation), but on being enrolled among the vassals of Kato Kiyomasa he became Uyeno Kizo. Keramic factories had existed in Higo for six centuries before Sonkai's arrival, but their productions were limited to coarse household utensils. The principal of them was at a place called Tôda, near the flourishing seaport town of Yatsushiro. Opposite to the latter lies the large island of Amakusa, long renowned for the excellence of its potter's earth (*vidê Kame-yama-yaki*). Sonkai, or Kizo, settled at Toda, and using one of the clays of Amakusa, which gave a fine, iron-red *pâte*, produced a faience called at first *Tôda-yaki*, and subsequently *Yatsushiro-yaki*. It is one of the most delicate and æsthetic of all Japanese faiences. The *pâte*, as has been said, is of exceedingly fine texture, and its red colour, combining with the pear-grey of the diaphanous glaze—which in the older pieces is uniform, lustrous, and minutely crackled—produces a tint of great richness. The decoration generally consists of storks flying among clouds, or of simple combinations of lines and diapers. It is

peculiar in the fact that the designs are engraved in the *pâte*, and afterwards filled with white clay before glazing. It is, in short, a copy of the Korean pottery known in Japan as *Unkaku* (clouds and storks), to which, though slightly inferior in point of glaze, it is decidedly superior in beauty and delicacy of finish. But, on the other hand, neither the *Yatsushiro-yaki*, nor its Korean progenitor, can by any means bear comparison with the Chinese faience, which is the original of both. Another very favourite variety of this ware imitates the Korean *Hakime*, or "streaked" pottery, in which the white engraved design is intended to represent the marks (*me*) of a coarse brush (*haki*), the intention being to convey an idea of boldness and rapidity of finish. The potters of Yatsushiro confined themselves almost entirely to this inlaid decoration. They never used enamels or pigments of any sort. Their wares, therefore, require little description, the universal characteristics being a fine iron-red or dark-grey *pâte*, a tolerably lustrous glaze, varying from pearl-grey to dark brown, and white inlaid decoration, the clay of the latter showing crackle of greater or less fineness.

It is the Henri Deux ware of Japan, the modern ware is very pretty and interesting, but of course one prefers the old and original specimens, such as this old red koro.

Banko Ware (Faience).

At the village of Kuwana, in the province of Ise, between the years 1760 and 1795, there lived a rich merchant, by name Kuwanami Gozayemon, who, in the days of his prosperity, turned his thoughts to garden-making, that refined extravagance which has always been among the first fancies of a wealthy Japanese. Until that time Gozayemon had given himself little concern about the "Chajin" and their tenets, but his horticultural predilections necessarily drove him to seek the aid of those masters of æsthetics. To this end he visited Kyôtô, and there became the pupil of a renowned *virtuoso*, from whom he acquired, not the principles of garden-making alone, but also that taste for keramics which forms an integral part of the tea ceremonials. The memory of the great potter Kenzan was then fresh, and the Kiyomizu factories had attained the zenith of their excellence. The merchant of Kuwana, now an ardent disciple of the *Cha-no-you* ethics, never wearied of wandering from workshop to workshop and watching the clay assume, under the touch of skilled manipulators, shapes the beauties of which he had newly learned to appreciate. His interest gradually developed into a desire to imitate. The Kyôtô potters were easily persuaded to explain their processes, and whether their pupil possessed some innate ability, or whether, as a wealthy amateur, he was able to command the best materials and devote ample time to the manufacture of single pieces, it is certain that, by the circle of friends who were so fortunate as to receive the products of his kiln, he was pronounced one of the best artists of his day. Yet, like the majority of Japanese keramists, he was an imitator, not an originator. The thick, unadorned Raku ware, and the ill-favoured Korean faïences supplied models that seemed not less worthy of reproduction than the delicate conceptions of Ninsei, or the bold designs of Kenzan. In both directions, however, Gozayemon was eminently successful; so successful that his fame reached the court of Yedo, and a special order was sent to him from the Shogun Iyenari (1785). No doubt such a commission incited the amateur to more than common exertions, for the proficiency he displayed induced the Shogun to summon him to Yedo. He accordingly moved to Komme, in the north-east suburb of the Eastern Capital, where he already possessed a residence, and there pursued his keramic pastime, under the patronage of the court nobles, Iyenari himself sometimes condescending to visit Komme and watch the elaboration of results which he so much admired. The effect of all this upon Gozayemon's reputation can be easily conceived. His ware became the rage everywhere—not, perhaps, for the sake of its merits alone, but also because of the difficulty men experienced in procuring it: for fame had made the artist capricious, and, since he did not work for gain, none but the favoured few might obtain specimens of his handicraft. He now no longer restricted himself to imitations of the ancient models, but, giving the reins to his fancy, turned out pieces which combined the graces of the Japanese school with the brilliancy of the Chinese polychromatic porcelain. Just then, however, the factories of the Celestial Kingdom, under the munificent patronage of the Emperor Chien-lung, were producing wares not unworthy of their ancient fame; and, side by side with these, the inferiority of the Japanese keramist's enamels became easily apparent. The Shogun, therefore, commissioned the Governor of Nagasaki to procure from King-te-chang the recipes used at the Imperial factory, together with a supply of the best materials. One

is a little puzzled to conceive by what means these instructions were carried out, but the Governor seems to have experienced no difficulty, for within a year he forwarded to Yeddo all that was required. With this aid, Gozayemon's success was more marked than ever. The best connoisseurs could scarcely distinguish his pieces from the Chinese porcelain decorated with red and green enamels of the Wan-lieh period (1673-1720), though, indeed, it must be confessed that the models he copied do not exhibit any very remarkable degree of keramic skill. His imitations of the Delft faïence, too, were certainly quite as good as the very inferior specimens of that ware which found their way to Japan; but of his achievements in this line we need only say that they would not be admitted into any respectable European collection. He only became great when, departing from his models, he combined brilliantly glazed surfaces with chaste floral decoration in the pure Japanese style. He imitated everything, from the rude faïences of Korea, and the grand colours of Cochin-China, to the severest styles of Ninsei and Kenzan. He generally marked his pieces *Banko* (everlasting or enduring), sometimes, however, adding *Fuyeki* (changeless). His productions are now known as *Ko-Banko-yaki* (old *Banko* ware). He died about the year 1800, at Kuwana, whither he had been recalled by Matsu-daira, lord of Etchiu, one of the most celebrated of modern *virtuosi*. Whatever talent he possessed died with him, for, since he cultivated keramics entirely as a pastime, he neither took pupils nor imparted his art to his children. One of his relatives, by name Takekawa Chikusai, who resided at Izawa, in Ise, made some attempts to continue the manufacture, or, rather, sought to obtain a market for his own wares under the ægis of the *Banko* stamp. But his productions were only tolerable so long as the materials left by Gozayemon remained unexhausted.

Like all noted amateurs, Gozayemon would probably have found imitators in later times. Yet, had it not been for an accident, his name would certainly be little remembered outside the circle of connoisseurs, of whose somewhat archaic creed he was so obedient a disciple, and in whose hands his comparatively scanty productions remained. That accident was the discovery—about the year 1830—of a recipe which he had employed in the manufacture of his enamels. The document containing the precious formula had found its way into the possession of a dealer in *bric-a-brac*, who lived at Kuwana, and whose son, Mori Yusetsu, had already gained some distinction as an imitator of *Raku* faïence. Fully appreciating the value of the knowledge thus strangely acquired, Yusetsu immediately set himself to profit by it; and, in order to give his counterfeit ware a greater semblance of authenticity, he persuaded Gozayemon's grandson to sell him the *Banko* stamp. Thus the works of the Ise amateur were again brought into public notice, and that rather by a freak of fortune than by any public knowledge of their merits. Yusetsu, however, was saved from performing the ignoble *rôle* of a mere imitator by his quickness of observation, for, detecting that the Chinese artists—whose works, like Gozayemon, he took as his models—used moulds applied internally for their more elaborate pieces, he immediately adopted that method in his own workshop, and so caused the name of *Banko*—for he still continued to employ Gozayemon's stamp—to be associated with the introduction of a valuable novelty in Japanese keramics. It has already been noticed that the Kyôtô artist, Mokubei, was the first to follow the Chinese example in the matter of moulds; but, whereas he fashioned his clay *in* the mould, Yusetsu reversed the process by putting the mould inside the vase, and pressing the clay with the hand into the matrix. The consequence is that his pieces carry their designs on the inner as well as the outer surface, and are, moreover, thumb-marked. Of course a mould thus employed was necessarily constructed on principles different from those which governed the Kyôtô process. Accordingly, we find that the mould of Yusetsu, instead of being simply divided into two parts, was built up of six, or eight, or sometimes twelve, longitudinal sections, which were withdrawn one by one after they had accomplished their end. The results displayed such clever modelling that they subsequently came to be regarded representative pieces of *Banko-yaki*. In fact, it is through the works of Yusetsu, or, rather, through the methods he devised, that the Ise ware has attained the wide-spread popularity it now enjoys; nor that undeservedly either, for some of the designs of his school exhibit a remarkable combination of artistic and technical excellence. Particularly worthy of mention are pieces ornamented with storks, dragons, and so forth, in relief, and others with clever arabesques in coloured slips on a green or rich

brown ground. All the *Yusetsu Banko* ware is faience, and the specimens are sometimes stamped "*Yusetsu*." Among his productions, a variety which often passes, or is made to pass, for "*Ko-Banko*," is a finely crackled faïence of a dark cream tint, decorated with blue under the glaze, and above it with a preponderance of red diapers, among which are reserved medallions containing landscapes or mythical subjects. Pieces in this style bear a considerable resemblance to the modern *Akahada-yaki*, but even in the absence of marks, the two may be readily distinguished, not only by the omission of the blue in the latter, but also by its denser *pâte* and the yellowish tinge of the body-glaze. The collector will generally be safe in attributing specimens of this nature to Yusetsu. Yuyeki, originally called Yohei, a younger brother of Yusetsu, was also an able artist—better, indeed, than Yusetsu himself, according to some authorities—and Mori-Yogozayemon, the present representative of the family, still carries on the manufacture. The reader will perceive, however, that in the hands of Yusetsu and his successors the *Banko* ware underwent a complete change of character. Of the finest old *Banko* enamelled ware I know no grander specimen than this magnificent plate. It followed me from Japan, for I could not acquire any really great example while I was there, and left a commission with Mr. Wakai, which he acquitted with his customary fidelity and good taste.

Sanda Ware (Celadon)—(Stoneware).

The province of Setsu lies at the head of the Izuminadi, which may be called the northern entrance to the Inland Sea. It contains the flourishing city of Osaka, and the foreign settlement of Kôbe. For many years Osaka has occupied the first place among the keramic marts of Japan, and, to this day, its *bric-a-brac* shops have no equals elsewhere in the empire. Yet the province possesses few keramic factories worthy of note. The principal is that of *Sanda*, established about the year 1690, by order of Kuki, lord of the district. The early *Sanda-yaki* was a pottery, closely resembling that of Tamba (*vide Tamba-yaki*); but, towards the end of the 18th century, two workmen, Uchigami and Ippei, succeeded in making themselves acquainted with the porcelain methods of Arita. Their ambition, apparently, was to copy Chinese celadon; but it was not till they obtained from Kyôtô the assistance of Shûhei, Kumachichi, and Kamesuke, pupils of the celebrated Rokubei, that they accomplished anything worthy of note. Then, indeed, their imitations of the much-esteemed "sea-green" became so excellent, that the achievements of all other artists in this regard were forgotten, and the term *Sanda-seiji* gradually passed into a synonym for Japanese celadon. It may be well, however, to remind the reader that more than a century before the appearance of the *Sanda-seiji* a celadon of much better quality had been produced at the Hizen factories, under the special patronage of Nabeshima, lord of the province. It would, therefore, appear that the celebrity enjoyed by the celadon of Setsu was in some degree a question of quantity, for while the outcome of the Hizen workshops in this particular variety was very small, being, in fact, confined to pieces for special use or presentation purposes, that of Sanda was abundant. In colour, the *Sanda-seiji* is a bright green, lacking the warmth of the Chinese *Schichi-kan-seiji* and the delicacy of the Nabeshima ware.

These Sanda cocks, this seated figure, and the water-jug, are characteristic examples, which you will judge for yourselves.

Miscellaneous.

Another great name among the Kyôtô keramists is that of Dohachi Takahashi, a contemporary of Zengoro Hozen. He commenced his career at a workshop in Gojo-zaka (Kyôtô) about the year 1825. He was a potter of considerable technical skill in the manufacture of his glazes, one of which, a peculiar dull white with a tinge of pink, is almost equal to Ninsei's work from which it was copied. The designs on his faïence also exhibit some of the most graceful conceptions of the truly Japanese school. In the year 1830, his reputation had become so well established that we find him employed as an instructor by the potters of Takamatsu, in Sanshu, and Himeji, in Banshu. It is curious, however, to observe that even at this late period of the art's history, alien influences are still perceptible. Prior to the enforced immigration of Korean workmen, the Taiko had attempted to achieve a mutual engrafting of the two countries' styles by importing, as models for the keramists of Japan, a quantity of Korean faïence. The chief characteristic, and, indeed, the only redeeming feature of the latter, which was called *Gohon*, or "Pattern-ware," consisted in light pink tints or flecks in the glaze, and these we often find exactly reproduced in Dohachi's best pieces;

side by side with designs not unworthy of Tanyu's brush. Strange that, after the lapse of two cycles and a half, the "plebeian prince's" conception should have been so perfectly realised by one of his country's most æsthetic artisans! In his old age Dohachi took the name of Ninami, with which also he marked some of his pieces. In general, however, he used the ideographs Do-hachi for this purpose.

Some Modern Potters.

I have left myself little time or space for speaking of some of the modern potters. Their work is exemplified on a table before you. I regret that I have not room in my collection —for room is our great difficulty in London— for larger specimens of their very fine work. The work of Rokubei of Seyfou, of Taizan and Tanzan at Kyôtô; of Inouyé of Tokio, of Maizan at Osaka, of Makuzu at Yokohama, is of the highest artistic merit. Rokubei is faithful to the traditions of the old Japanese school. His landscapes are still reminiscences of Tanyû, who painted on his ancestor's wares; and they take us back to the feudal traditions and the day of the tea ceremonies of Hideyoshi. I vainly tried to induce him to part with his ancestral series of specimens, but he is going to reproduce them for me (duly marked as copies). Seyfou is a genius, for whom the rarest glazes present no difficulties which he cannot overcome. His violets, aubergines, corals, and cobalt blues are extraordinarily brilliant and pure; and Makuzu, now that he has left off inundating us with sham Satsuma of gorgeous colouring and over-grown pretentiousness—of which I have also seen specimens enthroned in state in collections all over the world—is showing himself in his true light as a potter capable of rivalling the Chinese ancients in their most secret arts. Unhappily, his pieces are now being bought in China, and we may expect to see his extraordinary skill in glazes once more put to unfortunate uses. Maizan's decoration of Satsuma is illustrated in his larger style into groups before you. His exquisite miniature painting of chrysanthemums and butterflies, his missal-like figure-pieces, having the delicate character of old illuminations of mediæval MSS., are world-famous. He is, besides, one of the most modest, accomplished, and trustworthy of connoisseurs. His work is all signed, and will constitute one of the most interesting features of the exhibition of artistic pottery at Chicago, which will, I anticipate, be very fine.

DISCUSSION.

The Chairman said Mr. Hart had told them so much, that it would be difficult to select any points towards which discussion could specially be directed; but, in one or two directions, he thought Mr. Hart had opened up an important field of consideration: these were the relations of Japan to China in the keramic art, and the relations of Japan to Europe. In the relations of Japan to China, we had seen that the first decorative porcelain which the Japanese had produced was produced after a visit to China. At first this was blue under the glaze. At a later period, the enamels laid on over the glaze were apparently derived from personal instruction from a Japanese potter. Still later, special glazing had been introduced by Koreans and Chinese. The Japanese were largely indebted to China. In the relation of modern China, any one who knew the work the Chinese were producing, would see how far the pupils left behind their early teachers. There was nothing in modern China which would compare with the work produced from scores of kilns in Japan. In connection with the relation of Japan to Europe, it was only necessary to point out that all our fabriques in Europe were stimulated by the introduction of works which the Japanese did not think good enough to keep for themselves, work which they produced to give to us; and, even now, he was afraid the relations between Europe and Japan were by no means of the most flattering kind, as the Japanese sent to Europe work which none of them would possess.

Mr. Sleaden remarked that while the best examples of Japanese ware went to America, so also did the very worst; so that, while we could not compliment ourselves on our taste, as compared with the Japanese, we were not so bad as the Americans, and if we did not buy the best pieces, it was because our wealth was not so great. It was the very rich men in America who were able to buy those costly pieces.

Mr. Diosy said even the very worst forms of keramic ware, which the Japanese shot on to the rubbish heap of the commercial market in this country, served a purpose. Even the very commonest Japanese ware made for export had, in many cases, a certain charm about it, and very often qualities which were not to be found in goods of the same description and value made here. For instance, in a small tradesman's household, or on a cottager's mantelpiece, you might see a pilgrim bottle at 8¾d. Of course, it was not a very fine piece, and would probably be of a violent colour, which would horrify Mr. Hart; but it displaced a little white shepherdess, with gilt eyes and gilt lips, and a little gilt lamb by her side, which was a much greater crime against all good taste than even a slightly misshapen pilgrim bottle. Even a little imitation of Banko ware, given away with a 2 lb. packet of tea, was a better

education to the eye of a cottager than a Venus in Parian, who had become web-fingered through the exigencies of cheap casting. Therefore, though he hoped that Japan would, in time, send us only its good wares which did honour to its excellence, still a good deal of what was classed as rubbish was an advantage, inasmuch as it replaced much worse articles.

Mr. HUGH STANNUS said he for one was grateful for the clear light which Mr. Hart had cast on the past by his lucid explanation, and by the valuable specimens he had exhibited. He (Mr. Stannus) hoped that Mr. Hart would consider the possibity of a systematic nomenclature for these ornamental vases. People talked about gourd-shaped bottles, and so on, but there was no definite set of names such as were applied to Greek vases, and were well known to all. It would help the study of Japanese work, which he felt sure would receive a fresh development from this admirable paper, if some definite names were agreed on.

Mr. ERNEST HART, in reply, said a system of nomenclature did exist in fact, but Japanese was so much less familiar than Greek to most people, that he feared the terms were not generally recognised. If anything, there was an excessively minute nomenclature current in Japan, and some of the native connoisseurs had been rather grateful to Englishmen for substituting a more scientific and artistic system of criticism for their own, which consisted mainly of a system of shapes and uses. Any suggestion coming from such an excellent authority, and in itself so reasonable, would be well worth consideration, and no doubt the Chairman and other members of the Council of the Japan Society would take an opportunity of having it discussed.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Hart, which was carried unanimously, and the meeting adjourned.

Correspondence.

SIAM.

Are not the Panthays of Lord Lamington's valuable paper (p. 282) the Mussulmans who were expelled or fled from Yunnan after the defeat of Yakoob Beg?

HYDE CLARKE.

BURNING OILS FOR LIGHTHOUSES AND LIGHTSHIPS.

Your correspondent, Mr. William Love, as the representative in London of the Broxburn Oil Company, is entitled to be heard on behalf of the Scottish mineral oil industry, but, in the letter published in your last issue, he has certainly not exhibited that knowledge of the subject which he might fairly have been assumed to possess.

In the first place he takes exception to my statement that the definition of "inflammable liquid," in relation to lighthouse oil in the Inflammable Liquids Bill, was not objected to by the delegates of the Scotch oil companies, as likely to create a misapprehension, and as being somewhat misleading. He adds that "in the trade conference of 1891 the question of the standard of safety was purposely never under discussion, as the general provisions of the Draft Bill submitted for their consideration were felt to be so onerous that united trade action had become a necessity." Let us see what the circumstances of the case are. In 1891 there was a Bill, not a "Draft Bill," and the use of the latter term points to the conclusion that Mr. Love is referring to the trade conferences with Colonel Majendie in 1888, when the heads of the proposed Bill (substantially the Draft Bill) were under discussion. But whether he is or not, the fact remains that the definition of inflammable liquid was discussed, was actually modified at the request of the representatives of the Scotch oil companies, and appeared in the Inflammable Liquids Bill in the form in which it had been accepted by those representatives. I find that there were four delegates of the Scotch oil companies present when Mr. Mann, of Young's Paraffin Light and Mineral Oil Company, made the following remarks (I quote from the verbatim shorthand report, reprinted for circulation last year by the Petroleum Defence Committee:—"I beg to submit a suggestion that at p. 3, cl. 2, the specific gravity of ·865 be reduced to ·840, and the flashing-point of 200° to 150°. . . . . It would be a special relief to the Scotch trade, which has suffered for some time back, and has been almost annihilated, from low prices, if this specific gravity test were reduced to ·840. If the Government has fixed the point of safety for a flashing-point of other oil, and no doubt wisely fixed it, at 73°, I submit that a flashing-point of 150° for this oil may safely be adopted."

These remarks had special reference to intermediate oil, but they indicate very clearly that, as I stated at the meeting, the Scotch oil representatives did not take exception to the definition in relation to lighthouse oil at the time, when it is reasonable to suppose they would have done so if they had objected to it. They further show that Mr. Mann, the spokesman of the Scotch oil representatives, considered that the standard had been "wisely fixed" at 73°. So much for definition.

In the next place, Mr. Love, addressing himself to

the general question of the test standard in relation to accidents with lamps, seeks to prove that the standard of 73° F. is too low, and that if it were raised to 100° F., mineral oil complying with that test might be used without liability to accidents. To the experiments quoted by Mr. Love as having been made by Dr. Thörner, or rather to the deductions drawn from the results of them, I make the same objection that I did in the case of Mr. Price Edwards' experiments, and I must confess to some surprise that Mr. Love should have committed himself to the statement that "high-test oils, therefore, which give off no vapour under 100° F. never reach the point in ordinary domestic lamps at which vapour can be produced, and, consequently, safety in their use is insured." That very considerable heating of the lamp may take place in burning some descriptions of oil of high flashing point has been demonstrated. Thus the destruction by fire of the training-ship *Goliath* off Grays, in 1875, was due to the dropping of a mineral oil lamp which had become so hot that the boy who was instructed to remove it could not hold it, and it was proved at the inquest that the oil in use had been specially selected on account of its exceptionally high flashing point. The recent fatal accident to a well-known nobleman also affords indisputable evidence of the risk that may attend the use of high-test oil in lamps of imperfect construction, for in this instance the oil had a flashing point of 110° F. (Abel test), and it is worthy of note that, in a previous similar accident to the same nobleman, resulting in personal injuries, oil of the same high flashing point was implicated.

In the remarks which I made at the meeting, I desired to counteract the impression likely to be conveyed by the statements of Mr. Price Edwards, that an oil of high flashing point was necessarily one which could be used with safety, for as Sir Frederick Abel very clearly demonstrated in a lecture delivered at the Royal Institution, in 1885, safety in the use of mineral oil lamps is not to be secured by the employment of oils of very high flashing-point. I maintain that the exisiting standard of test has not been shown to be too low; and I may remark, in conclusion, that this attitude is not inconsistent with the advocacy of the use, under certain circumstances, of oils of higher flashing-point, apart from the fact that such oils may be selected on the ground of other qualities which they also possess.

Mr. Love is unfortunate in citing the late Mr. Charles Marvin in support of his views; for I am reminded that, in a letter, published in the *Globe* in 1888 (July 3rd), Mr. Marvin used these words:—"The allegation of a Midland firm of lamp makers, that most of the accidents are caused by under-standard petroleum, is about as satisfactory as the allegation of the Secretary of the Scottish Mineral Oil Association, in 1886, that no accidents had occured with Scotch paraffin for 37 years."

BOVERTON REDWOOD.

February 24th.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 2.—Prof. VIVIAN B. LEWES, "Spontaneous Ignition of Coal, and its Prevention." Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

MARCH 30.—EWING MATHESON, "Foreign Exchange."

Papers, the dates of reading of which are not yet fixed:—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru: its Commerce and Resources." CLEMENTS R. MARKHAM, C.B., F.R.S., will preside. 8 p.m.

APRIL 5.—The Rev. JOHN MCLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MARCH 3.—Surgeon-General Sir WILLIAM JAMES MOORE, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene." Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., will preside.

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

There will be no meeting on March 8, as previously announced. This will be replaced by a meeting on May 31.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

LECTURE I.—FEBRUARY 29.—*Properties and Uses of Petroleum in Prime Movers.*—Oil testing—Specific gravity, flashing point, composition—Expansion—Distillation—Vaporisation of oils—Spray-making and carburetting devices in modern oil-engines—Pressure of petroleum vapours at different temperatures—Behaviour of different kinds of oil in engine cylinder—Other properties of petroleum as heating and working agent.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. William Robinson, "The Uses of Petroleum in Prime Movers." (Lecture I.)

Farmer's Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Prof. Axe, "Abortion in the Live Stock of the Farm."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. J. W. Grover's paper, "An Explanation of the London Water Question."

Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. 1. Mr. John Foggie, "The Analytical Aspect of Ventilation by the Propulsion and Extraction Systems, in relation to Organic Matter and Micro-Organisms in the Air." 2. Mr. William Key, "The Ventilation of Buildings mechanically by Propulsion, with Screened, Washed, and Warmed Air, without Draughts."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Israel Gollancz, "The Saga of Hamlet."

TUESDAY, MARCH 1...Royal Institution, Albemarle-street, 3 p.m. W., Prof. Victor Horsley, "The Brain." (Lecture VII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by (1) Mr. W. T. Douglass, "The Bishop Rock Lighthouses;" (2) Mr. David C. Salmond, "The Illumination by Gas of Tory Island Lighthouse, Co. Donegal."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W, 8½ p.m.

WEDNESDAY, MARCH 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Vivian B. Lewes, "Spontaneous Ignition of Coal, and its Prevention."

Entomological, 11, Chandos-street, W., 7 p.m.

Archælogical Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W. 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. J. Friswell, "Some Practical Notes on the Water Supply of Boilers."

THURSDAY, MARCH 3... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Surgeon-General Sir William James Moore, K.C.I.E., "Indian Sanitation and the International Congress of Hygiene."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. D. Michael, "Variations in the Internal Anatomy of the *Gamasina*." 2. Mr. Allan Swan, "Vitality of Spores of Bacillus."

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Dr. A. C. Mackenzie, "Orchestral Music in the 16th Century.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. P. Ker, "The Progress of Romance in Middle Ages. (Lecture I.)

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, MARCH 4... United Service Inst., Whitehall-yard, 3 p.m. Lieut. F. J. Davis, "The Employment of Photography in Reconnaisance."

Royal Institution, Albemarle-street, W., 8 p.m. (Weekly Meeting, 9 p.m.) Prof. L. C. Miall, "The Suface Film of Water, and its Relation to the Life of Plants and Animals."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. S. P. Thompson, "Modes of Representing Electromotive Forces and Currents." 2. Prof. Maurice Fitzgerald, "The Flexure of Long Pillars under their own Weight." 3. Prof. J. Perry, "Choking Coils."

SATURDAY, MARCH 5...Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Prof. W. C. Roberts-Austen, "Art Metal-work."

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture IV.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,050. Vol. XL.

FRIDAY, MARCH 4, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The first lecture of the course, on "The Uses of Petroleum in Prime Movers," was delivered on Monday evening, 29th ult., by Prof. WILLIAM ROBINSON. The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 2nd inst. Present: The Attorney-General, M.P., Chairman of the Commission, in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., B. Francis Cobb, Prof. James Dewar, M.A., F.R.S., Sir James N. Douglass, F.R.S., James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. Malcolm Kennedy, C.B., Professor W. C. Roberts-Austen, C.B., F.R.S., with Sir Henry Trueman Wood, Secretary of the Commission.

COMMITTEE ON AGRICULTURE.

A meeting of the Agriculture and Food Products Committee of the Royal Commission for the Chicago Exhibition of 1893 was held on Monday, 29th ult., at 12, Hanover-square. Present:—Earl of Feversham, President of the Royal Agricultural Society, in the chair; R. Bannister, James Bell, D.Sc., C.B., F.R.S., J. Bowen-Jones, W. Burdett Coutts, M.P., Earl Cathcart, Earl of Coventry, Alfred Darby, Walter Gilbey, John Gilmour, Captain Heaton, Lieut.-General Michael, C.S.I., Ralph Palmer, Albert Pell, G. H. Sanday, John Thornton, Dr. J. Augustus Voelcker, and Ernest Clarke, Honorary Secretary of the Committee.

LADIES' COMMITTEE.

A meeting of the Committee of Ladies for the Women's Work Section of the Chicago Exhibition was held on Wednesday afternoon, 2nd inst. Present:—H.R.H. Princess Christian, President of the Committee; the Marchioness of Salisbury, the Countess of Aberdeen, Lady Agnes Burne, Lady Egerton of Tatton, Lady Knutsford, Lady Galton, Lady Jeune, Lady Roberts, Mrs. Tyssen Amherst, Mrs. Bedford Fenwick, Mrs. David Carmichael, Mrs. Priestley, Mrs. Roberts-Austen, Miss Forsyth, Miss Emily Shaw-Lefevre, Miss Webster, and Miss Fay Lankester, Secretary of the Committee. The following members of the Royal Commission also attended:—The Attorney-General, M.P. (Chairman of the Commission), Sir Frederick Abel, K.C.B., Sir George Birdwood, K.C.I.E., Major-General Sir Owen Tudor Burne, K.C.S.I., and Sir Douglas Galton, K.C.B., with Sir Henry Trueman Wood, Secretary of the Commission.

COMMISSION FOR BERMUDA.

The Governor of Bermuda has informed the Secretary of the Royal Commission that the Colonial Legislature have made a grant to provide for the representation of the Colony at the Exhibition, and that a Commission has been appointed for the purpose of making the preliminary arrangements.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above. Applications can now only be received subject to space being available.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 23rd, 1892; Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., in the chair.

The paper read was—

ARTISTIC TREATMENT OF JEWEL AND ADDRESS CASKETS.

By J. William Tonks.

The subject I have chosen for this evening has been invested from the earliest times with an atmosphere of poetry and romance. It is a central element of one of the most interesting Greek myths; it furnishes a principal scene in one of Shakespeare's finest dramas, and it has in all ages been adopted as an apt and suggestive symbol. Thus an old poet exclaims:—

> "O ignorant poor man! What dost thou bear
> Locked up within the casket of thy breast?
> What jewels and what riches hast thou there
> What heavenly treasure in so weak a chest?"

It is more significant that in the most ancient literature to which we have access, a casket, a box, an ark, contained the most sacred religious symbols, while its golden summit reflected the messages of mercy from the Most High. We are told that Bezaleel (Exodus xxxvii. i. 9., revised version), the earliest goldsmith whose name has come down to us on the tide of history, made an oblong box, whose proportions were strikingly similar to those adopted for caskets in the best periods (2½ by 1½ by 1½), for the purpose of containing sacred symbols. The box itself was of acacia wood, this material being of an enduring character; and this body was lined and covered with gold. A crown, or raised moulding of gold, was placed along the upper edge. Then four rings of gold were fixed on the lower sides or literally "ribs" of it, through which were placed two thin poles or staves, also covered with gold, and by means of which it was carried about after the manner of a palanquin. The box was covered with a dome or "mercy-seat" of gold, so made that it could attract light and focus its effulgence to the spectator. At each side were mystic, winged figures of cherubim, of beaten work in gold, facing each other, and with wings stretched on high towards each other, in striking resemblance to the style adopted in portraying winged figures in the most ancient Egyptian hieroglyphs.

This description is of importance, not only as marking a high degree of artistic achievement, but as also affording a kind of model upon which works of this kind in various countries have afterwards been constructed. It derives additional interest from its close relation to early Egyptian forms, and which to some extent it aids in explaining. In the magnificent series of illustrations prepared under the direction of Champollion le jeune, during the invasion of Egypt by Napoleon I., there is a remarkable drawing which I have roughly figured. It represents a box of ancient character, having a rim or moulding, the form observing the proportion of 2½ by 1½, and having in centre of body two open eyes, probably representing the unsleeping watchfulness of the Almighty. This box, curiously enough, has two poles or staves, and these proceed from the ribs, in fact they partly complete the form of a highly conventional lion. The lion, as suggestive of power, is evidently symbolic. Another singular figure, also from Champollion, is an ensign, apparently formed of a sloping side box, with an animal, perhaps a fox, seated on top. I fear this is attributable to a much later period, as there is in the South Kensington Museum a wooden box very similar in shape, but without any figure surmounting it, and which may be either a casket, or a *chasse*—a depository of the relics or ashes of the dead.

Coming from Egypt to Greece, a true historic transition, we first begin to find the jewel casket. This was called by the Greeks and Latins "pyxis," probably because originally made of box-wood, and in it they placed and kept for safety their parures or jewels. The simple box-wood caskets, quite adequate in those early days, are often figured upon the exquisite vases that have come down to us. I have here enlarged two specimens from vases in the famous Englefield collection. They are oblong, simple in form, consistent with their use, and with the purpose they were designed to serve, the decoration being always in conventional and geometric bands. The proportion usually adopted is still that of the sacred box or ark of the Israelities, 2½ by 1½ by 1½. I know but of one example in the cubic form, but that again illustrates the principle. It is that of the statue of Venus rising from the sea, in the Chigi palace. The goddess has one of these oblong caskets at her feet, thus sufficiently indicating their use and the devotion of their contents to the adornment and service of beauty.

It is a singular and suggestive fact that in the Greek mythology, a box or casket is intimately related to the first mortal woman who was created. Prometheus, one of the earliest mortals, whose name has ever since been held as the synonym of Genius, exceeded all others, we are told, in ability and artifice, so much so that he was able, at a famous sacrifice, to deceive even Jupiter, the chief of the immortal gods. To punish him and his

fellows, Jove is said to have taken fire away from the earth. But, assisted by Minerva, the goddess of Wisdom, the undaunted Prometheus climbed the heavens, and stealing fire from the chariot of the Sun, brought it down with him to the earth. The father of gods and men, enraged at such audacity, ordered Vulcan to make a woman of clay, and, after giving her life, to send her to Prometheus, with a casket of costly presents from the gods. As soon as she was endowed with life, all the gods and goddesses of Olympus vied with each other in presenting her with gifts. Beauty and the art of enrapturing the children of men she received from Venus, and from the Graces all their captivating charms. Apollo taught her to sing divinely, Mercury gave to her the most persuasive eloquence of a woman's tongue, and Minerva blest her with a wise discretion. Hence she was called Pandora, from Greek words signifying "all-gifted." But Jupiter himself presented her with a last and fatal gift. It was a casket filled with innumerable ills, which she was desired to offer to the mortal who espoused her. Mercury himself conducted this lovely creation to Prometheus, clad in all her charms. The wary and sagacious mortal, whether from the lofty disdain born at times of highest genius, or from a cool judgment which led him to suspect that there was danger in the all too glorious vision, to the surprise and anger of the immortals, declined the proffered bliss. Unfortunately for poor humanity, Prometheus had a brother, Epimetheus, less wary, or more sensible to female charms, who was entranced by the beauty of the heaven-descended maiden, and immediately rushed into her arms. He married her, received the box, opened it in haste, when there issued from it a multitude of evils and distempers, which speedily dispersed themselves over all the earth, and which have not since ceased to afflict mankind. He shut the casket again in haste; but nearly all were gone. Hope alone, which Jove had compassionately enclosed in this unhappy gift, had not time to escape from the box. Hope, therefore, remains as the only consolation left to unhappy mortals amid all the ills that flesh is heir to.

This beautiful myth is so closely related to my subject, that I could not forbear recounting it. The curious may find in it a singular analogy, with the symbolic allegory of the origin of evil, given in the most ancient portion of the Hebrew Scriptures. The Greek form is much later, is less direct, and more poetic in treatment; but the fact that, in Greek myth, Deucalion, the grandson of Pandora, is the Noah of the Grecian Flood, seems to emphasize the conclusion. It might almost have been thought, that as a casket, the dower of a woman, was the source of such mischief, it would have been a discarded object. But this was not so. The joy-loving Greek might laugh at the early perils of the jewel-box, the witty poet might fable in veiled satire the dangers of the female love of ornament, but the casket, nevertheless, grew richer and more decorative age by age. The wooden box was overlaid with ivory, silver, and, at last, gold, with gems and other costly materials, treated generally with panels, and in conventional style, as seen on the later Greek vases. During the Roman period, as riches and luxury increased, these naturally became more elaborate. Dress and ornaments with many became the chief object of attention, until a lady's toilet and ornaments became known as *mundus muliebris*, her world.* There came into use a special case, formed of some rich material, called *Dactylotheca*, wherein a large array of rings were kept.†

It is a matter of interest that one of the first gold caskets of which we have a record has relation to a remarkable Roman custom, in which—contrary to the Greek legends—the sterner sex were concerned. It was a habit to allow the beard to grow until about the age of 21; the young man then began to shave, and the first crop of beard was consecrated to some god; the day was held as a festival, and presents were sent to the young shaver by his friends.‡ Thus, the young Nero, whose early reign was as promising as its end was infamous, consecrated his beard to Jupiter Capitolinus, enclosing it in a veritable golden casket (*pyxide aurea*), the borders being set with pearls.‖ The melancholy fact is, in regard to all these examples, doubtless exhibiting, in a high degree, the art, as well as the luxury, of each successive period, that nothing now remains to us but an accidental record. This was, indeed, hardly to be expected in regard to the Roman world. As Byron powerfully expresses it:—

> "The Goth, the Christian, time, war, flood, and fire
> Have dealt upon the seven-hilled city's pride;
> She saw her glories, star by star, expire,
> And up the steep barbarian monarchs ride,
> Where the car climbed the capitol."§

* Liv. xxxiv., 7. † Martial xi., 60. ‡ Juvenal, iii. 187; Petron. 29. ‖ Suet. Ner. 12. § "Childe Harold," c. lxxx. 4.

By the burning of the Alexandrian Library, even the record of these pieces is mainly lost. There were, indeed, general causes, which have operated through long ages, and have prevented our being able to refer to examples of these far-off times. The very richness of the material has occasioned the loss of many artistic treasures; the cupidity, the necessity, the repeated disorders of so long a course of canturies have ensured their destruction; while fashion, that goddess of change, whose destructive worship belongs to every age, as M. Labarte remarks,* has contributed even more than these combined causes to the breaking up of the finest specimens of the goldsmiths' art. It is only, therefore, by the examples left us, in materials which it would hardly pay to disfigure or destroy, that we can pursue the historical aspect of our subject.

It seems a far cry from the gold casket containing the beard of Nero, to those enclosing mementos of martyrs of the Christian Church, but such is the irony of historic fate. The custom arose, even in the early times of Christianity, to take out of the catacombs memorials and even portions of the remains of martyrs and other saints, to enclose them in boxes or other ornaments, and to wear them as amulets. Such small holders were generally worn on the breast, from which they receive their name "encolpia." They were mostly small rectangular caskets of precious metals or of common materials, ornamented with the emblems of the Saviour or with Biblical illustrations. Two golden encolpia of this kind were found, in the 16th century, in the grottos of the Vatican. The simplest holders of such relics are the numerously-occurring caskets and round boxes of ivory, adorned with ornaments or with reliefs, also caskets of fine kinds of wood, or such as are covered with embroidery and enamels. Perhaps the most valuable—at any rate, the most significantly artistic work of this kind—is an antique onyx vessel, with a relief picture in the style of Greek art, in the treasury of the Abbey Church of St. Maurice in Wallis, and which, according to tradition, was a present of Charlemagne.

Here let me say a word in reference to our National Art Museum. I have had the advantage of seeing most of the collections in Europe, north of the Alps, and am free to say that, as a typical collection of caskets, coffers, and marriage chests or *casoni*, the South Kensington examples stand first. I do not refer to what are called cabinets, in which, so far as value and variety are concerned, the Green Vaults at Dresden must carry off the palm. But I am forced to agree here also with M. Labarte, in his opinion that many of these pseudo-architectural productions are, after all, but elaborate artistic follies. For art, value, and guidance, I think we have reason to be satisfied with our own national collection; and I am happy to be able to refer to some of them, which have been kindly lent for the occasion.

One of the most interesting examples is an ivory carved box (10-66), with silver frame and mountings of decided Byzantine character, believed, with good reason, to be the work of the 10th or 11th century. It is oblong in form, with feet, and a lid resembling a penthouse roof in character, and the body following the Mosaic proportion generally, $2\frac{1}{2}$ by $1\frac{1}{2}$ by $1\frac{1}{2}$. The surface is in bas-relief, almost flat, but the ground is cut down very deeply; thus giving an effect of unusual boldness and force.

The only pieces which came near to the nature of caskets, produced about this time in Western Europe, were oblong shrines or really boxes, having pointed gable lids similar to the roofs of the ecclesiastical buildings of the period, and made to contain what were held to be the most precious treasures of the Church. These were the reputed relics of the greatest saints of old, and hence the name *chasse* was given to the smaller boxes, while the term shrine was retained for the larger ones. One of the earliest and finest of these is the "Shrine of the Magi," in Cologne Cathedral, which dates from the 11th century. The front is surrounded by a border of gold, decorated alternately with precious stones, *en cabochon*, and enamelled ornaments in gold filigree. A series of arches decorating the sides are each cut out of a single plate of metal, decorated with *champ-levé* enamels. A very fine enamelled shrine of the 12th century, in the Soltykoff collection, with subjects representing the entombment and the resurrection, deserves mention; while a beautiful enamelled *chasse* of the same period in the British Museum, the subjects represented being the Virgin and Child, with apostles; should be examined, as a remarkable specimen of the time.

I am fortunate in being able to show one of these religious caskets (7945-62). The shape is the usual one, with a high ridge roof, the enamels are on copper, and the figures are of

* "Arts of the Middle Ages," c. vii.

the usual treatment, though it is difficult to fix the date of its execution.

We are now approaching a time when the secular casket, as such, began to appear. The dower of a lady of the Middle Ages was often enclosed in two boxes of very different sizes. One was large, of bold and often beautiful proportions and called *casone* in Italy, *bahut* in France, and chest in England. These contained the dresses and larger valuables of the lady's wardrobe. The smaller box, called *coffret* in France and casket in England, held her jewels, money, and treasures which lay in small compass. This is illustrated in the words of Shakespeare, "I have writ my letters, casketed my treasure, and given orders for our horses." These caskets were often of wood or ivory, charmingly carved, of wood covered with gold, silver, or brass; wood with decorated leather, at times silver and gold, lastly, of iron or steel.

A carved oblong box of maple wood (1167-64), with severe Gothic arches and panels, boldly cut, marks a transition period. It is said to be German work, probably of the 14th century, and is so ecclesiastical in spirit that it is difficult to say if it was originally a lady's casket, or an *armoire*, a name given in France to treasure boxes of the church. Another casket (176-66), with panels of bone of shape well-defined and boldly divided, is carved with events from the life of the Virgin, also Gothic in panels and arches, but the style is more free, and the box is more clearly intended for a lady's jewels. The date is about the 15th century. Another casket, Italian, of the same date, is one of the treasures of South Kensington Museum (706-1884). It was purchased from the Castellani collection at a cost of some £500, is of silver, parcel gilt, with sloping lid, oblong in general form, with four small feet; its chief glories being a series of quatrefoil plaques in translucent enamels, upon figure groups embossed in low relief, and the details afterwards engraved after the method described by Cellini*. The subjects are scenes in the life of the Saviour, of the Virgin Mary, and Saints. These enamels, which give so much value to this piece, have lately been reproduced as to their essential character by Falize, of Paris.

Let us now turn to another type of box, less ambitious and costly, but, withal, marked with much feeling and style. It is of wood covered with leather (2180-55), *cuir bouilli*, is oblong in shape, enriched with incised patterns in low relief, a leading shield of arms, and Latin and Italian inscriptions; the date is given as 1490. There is also a larger *coffret*, leather-covered (898-1877), decorated with Scripture and hunting subjects, which is interesting, and deserves examination.

There is a curious casket (2168-55), stated to be of the 14th century, but which cannot, I think, be much earlier than the period at which we have arrived. It is oblong, of wood, covered with stamped and gilt brass work, having rosettes, heads of queens, and sphinxes, in alternation, showing much effect and colour, the surface being varied and rich. It is bound with twisted brass bands and clamped, so that the necessary strength is not lost sight of in the search for decorative beauty.

We now come to the iron age in caskets—the time when it was requisite to take more precautions than formerly against theft and violence. This iron age may, indeed, probably have begun at a much earlier period than the authentic examples left us would indicate. They were also used, as we learn, by nobles and knights, no less than by the fairer sex. M. Viollet le Duc informs us*—"During their journeys ladies carried them with them, and kept their jewellery in them. In the country, in distant expeditions, the nobles and knights, besides the trunks which contained their effects, took these caskets, which were confided to the charge of the squire, and contained money, jewels, and sometimes even title deeds; for it was no unusual thing, even up to the 13th century, to carry about with one family papers and important deeds."

While, then, the richly carved ivory box, the jewelled and enamelled casket, were most appropriate for fixed positions in the hall or castle, the iron casket, with its strength and elaborate lock, was more suitable for travel and dangerous service. There is a typical one in South Kensington Museum, which combines strength with beauty (87-65). It is of iron, oblong, having an elaborate lock on lid, and was made in Augsburg about A.D. 1530. The form is excellent, having a raised moulding on lid to protect the lock-plate, with gilt metal corner pieces, while the general surface is finely engraved with winged unicorns and arabesques. There are great numbers of these iron caskets, of uncertain dates, in museums. Messrs. Hardman, of Birmingham, exhibited one in 1862, of which I have an

* "Trattato dell' Orificeria." Milano, 1811, p. 45.

* "Dictionnaire raisonné du Mobilier Francais."

illustration. It had an arch top, with handle on lid, was appropriately decorated with rose-sprays, and parcel gilt. But Messrs. Chubb have probably come nearest to the mediæval idea, with their drawing-room safes opened by golden keys.

From iron we pass to bronze. There is a charming little box (2084-55), bronze gilt, arched at top, and handle as last described, with arabesque ornament in relief, and the legend of Orpheus given in panels, which leads us to less troublesome days. To show how long the strong box idea lasts, however, there is an interesting example of Dutch 18th century work (1130-1864). It has a curved lid, strong lock, hinges, framework, and angle-plates in brass open work, the panels, however, being much contrasted by being made in cane wicker plaiting.

There is also a very fine and characteristic box, English, of the 17th century (619-1890), which I should not omit to refer to. It is large, oblong, with lock and handle at top, is of wood, covered with brass *repoussé* work, roses, tulips, and trefoils, bound with iron, and studded with nails, the whole surface work being artistic and appropriate.

We will now take a step southward, and regard for a few moments the Italian marriage caskets of the Middle Ages. These caskets are of wood, ornamented with pounced patterns, and covered with most minute and beautiful subjects, figures, foliage, and ornaments in fine paste or stucco, probably the work of Francesco l'Indaco or his followers. Of these works in *gesso-duro*, South Kensington has a series, and the one I have noted is a typical example (110-1887). It is oblong, with sloping lid, the panels having raised figures, in processional groups. Gifts, music, &c., probably marriage offerings, are shown on the lid, shields of arms in positions of vantage. The *gesso-duro* is white upon blue and gilt grounds, and the legend, *Omnia vincit amor*, is shown on a painted riband on the centre panel of lid. While referring to Italy, it may be well to observe that the motive of the wood casket, richly carved, gilt, painted in imitation of enamels, and of massive, oblong form, has been retained until the present day. A fine example of this is the jewel casket of the late Cardinal Antonelli, exhibited in 1862, and of which I have an illustration. It was executed by Fiorentini, of Rome; at the base are lion supports, and the four great prophets; at the angles are figures of the twelve apostles, each corner has a statuette of one of the evangelists. Allegorical figures adorn the panels, the centre one containing the Cardinal's arms and insignia. The rich foliage of the cover is in open carved work, over which is a seated figure of religion on a lion-headed throne, and holding the keys of S. Peter.

We are told of the immense number of caskets of great value and beauty, produced by the Limoges enamellers as early as the 11th, 12th, and 13th centuries. I have before referred to the ecclesiastical ones, but for the lay caskets I fear we must go to a later period. The example from South Kensington, of uncertain date, illustrates the style (1440-'55). It is oblong, ebony and gold, with five enamel painted plaques, of the modern Limoges type, which I need not further describe. The charming little silver box, of classic type, lent me by Mr. Camden Piercy, has a series of enamelled panels of Roman subjects, probably of a not much later period; while a silver open-work box, from the same collection, may carry us to the 18th century. We then come to the time of the Battersea enamels. Caskets, painted in delicate colours, with views, flowers, fruit, and foliage, are not infrequent in collections of this ware.

A notice of caskets would be seriously incomplete did it not refer to the famous ivory and metal workers of the far East. Arabia, Persia, and India have been so long famed for their productions, that there must be many of the highest lessons to be gained by a study of what the wrecks of time have left us. Firstly, the Arabic motive seems quite different from the European. The box is of metal, damascened; it is quadrilateral in plan, with sides sloping towards the top and sloping lid, the feet being in line with the box. A very precious example is at South Kensington (459-1873). It is in brass, covered with silver plates, chased with foliage, birds, and human-headed lions, inlaid with gold, also with geometric designs and Arabic inscriptions, carried out in superb style and finish. It has silver chains to support the lid when open, and Mr. Purdon Clarke considers it is Mosuli work, perhaps as early as the 13th century.

Modern Persian work reverts to the oblong box, as a rule. A box with falling front and fittings, as a cabinet (1090-'75), is richly inlaid on wood, after the Persian manner, with figures, animals, and foliage, the materials being vari-coloured pieces of ivory and brass wire. A more ambitious box, probably dating from the commencement of the present century, and covered with Shiraz mosaic, the lid being

brass, and having a border pierced and engraved with figures, and Persian inscription, is inlaid charmingly with silver, and prominent lines of border are decorated with turquoise and garnet.

I learn from my friend, Mr. C. Purdon Clarke, who has given so much study to Oriental art industries, that the usual jewel-box in India is circular, carved and decorated, in which, also, perfumes and other toilet requisites are kept. As to the ancient Indian casket, one of the best examples we have (8495-'63), and which I am fortunately able to show, is curiously related, in shape and character, to the ancient Byzantine one, to which I have already referred. It is ivory, oblong, with pent-house lid, and an ebony slab, which is an ugly late edition. Like the former one, it is constructed with bold ornamental divisions, the plaques of ivory between being very boldly carved with grotesque human figures, curiously squeezed into the panels. The nails are shown with commendable frankness, and the two caskets are well worth studying together.

A modern Cingalese casket (38-'68) is again, with its arched top, curiously related in shape to the ancient Italian *casone*. The ivory openwork ornament is, however, very refined and harmonious, showing against the darker wood back-ground in a very interesting manner. The carved monsters and foliage appear to betray a European influence, but the treatment is all that need be desired.

After roaming among historic records, and reviewing from the fragments that remain to us the art work of so many nations, it is a confession that one may perhaps make with some equanimity, that the address casket, strictly such, may be styled a feature peculiarly English. After some little research into the habits of the past, it is noteworthy that history seems eloquently silent as to a custom of presenting addresses in a box of some precious material or artistic construction. I was especially interested, in 1878, in examining the wonderful collection of ancient art treasures in the halls of the Trocadero at Paris. There were many superb specimens of caskets, but none that appeared specially designed to enclose addresses. We must not forget the wholesale destruction of art treasures by Louis XIV. at the latter part of his long wars against the Allies, nor the melting down by Louis XVI. of the contents of the treasury of St. Denis, which M. Philippe Burty describes as a calamity for art, as great as that of the burning of the Alexandrian Library was for literature. Still the fact remains, and it is a singular one. As a member of the Jury at Paris, in 1889, I had special facilities for examining the goldsmiths' work, in what was perhaps the finest Exposition of modern work the world has yet seen. But in that display I do not remember a single Continental example of a casket produced to receive an address. So far, then, we have a claim to believe that the system is of English origin.

The custom of bestowing the freedom of a city is of very ancient date, and I may be excused from giving details of it here. This freedom, usually obtained by service, was given on a parchment certificate, signed by the chief magistrate, and enclosed, usually, in a cylindrical box of box-wood, much after the style of a needle case, in which it would closely fit when rolled. But when a city became rich and powerful, it was in a position to confer distinction upon men who had deserved well of their country, by offering to them the honorary freedom, and enrolling their names on the list of its citizens. The occasion was one of great ceremony, and it would naturally be felt that the ordinary boxwood "pyxis" would be quite inadequate for the purpose. So a more elaborate box was provided, which has gradually developed into the modern address casket. The city of London appears to have set the example in this respect; but it is unfortunate that its records are so meagre, and that early tabulated accounts have been destroyed. Further research may bring to light much important information, but a systematic statement in the Chamberlain's office commences with the year 1740. From this, it is clear that the practice of giving the honorary freedom of the City to eminent persons was in full swing, as also the custom of enclosing it in a gold casket. Thus, in 1740, Vice-Admiral Vernon was presented with the honorary freedom in a gold box, after the victory of Portobello. William, Duke of Cumberland, had a similar distinction, after the defeat of the rebels in 1745; and William Pitt, afterwards Earl of Chatham, in 1757, at the close of his first short administration. The Right Hon. R. B. Legge was bracketed with Mr. Pitt for a similar honour; and so the list goes on at regular intervals. In 1767, Christian, King of Denmark, was singled out, on a visit to this country; and the gold casket is noted as having cost 200 guineas, a much larger sum, relatively, in those days than it would be esteemed now. Rear-Admiral Rodney received

a gold box from the City in 1780, on returning from his famous victory; and, in later days, Nelson and Wellington accepted these marks of respect and admiration from the City. But we get from the records the mere statement of the fact, and the money value of the gold caskets, with no description that would enable us to form an idea of their respective artistic merits.

There is one interesting fact in connection with these early address caskets which must not be omitted here. Charles Dibdin, the famous song writer, was, at the date at which we have arrived, in the vigour of his age, and near the summit of his reputation. We all remember the famous couplet in one of his patriotic odes,—

> "Our ships are made of oak,
> And hearts of oak our men."

Now, I must leave it to the learned to determine whether, in some one of the 1,400 songs this prolific writer produced, the phrase "hearts of oak" had occurred previous to the year 1779. But in that year, curiously enough, there was presented to Sir Augustus Keppel the first "heart of oak" box, embellished with gold. Whether the custom gave rise to the song, or the song to the custom, I have not been able to ascertain. But the custom became general, so far as the City of London was concerned, and continued for some sixty years. I have seen one of these "heart of oak" boxes. It was of a fanciful rococo shape, about the size of a club snuff-box; in fact, it was lined with burnished gold, and so exactly fitted to close air-tight, that it would well have served the purpose. The wood was of that delicate rich brown colour, finely grained, characteristic of the heart of the oak, and which does not seriously darken in a century. The lid was covered with richly carved rococo scrolls, the arms of the recipient in centre, and at sides were military trophies suited to the presentation.

In coming now to modern times, I am reminded of the fact that the reason why Chairs of Modern History are not more largely founded at our Universities, is because of the risk that the professor's views of recent events may be largely coloured by his political predilections. It is evident that similar risks are run by one who dilates on modern industrial art. Should he adopt a tone of caustic censure, he is liable to be reminded of Lord Beaconsfield's famous aphorism, that "Critics are persons who have failed in literature or art." If, on the other hand, he should indulge in exuberant praise of the objects under review, he may be asked the question "Who are your friends?" I must therefore crave your indulgence while I endeavour, on this subject, to steer between Scylla and Charybdis, simply premising that the examples have been drawn from as wide a field as possible. I can deal with but a few pieces; it is only safe to speak of those of which one has some knowledge, and I propose to suggest a few lines of thought for your consideration, rather than to set down a hard and fast dictum of praise or blame.

A casket presented to the Rev. T. Raffles, of Liverpool, after a pastorate of fifty years in that city, and exhibited by Messrs. Howell and James, at London, in 1862, has refinement of form and dignity of expression. It was designed by Mr. F. M. Miller, professor of sculpture at South Kensington. A much later one, presented to Sir Frederick, now Lord Roberts, after his remarkable march from Cabul to Candahar, was also produced by Messrs. Howell and James. It was in gold, oblong, with arched top, after the style of the Italian *coffret*, and the design, for which Mr. T. Buxton Morrish was largely responsible, included enamels and *repoussé* work, all having a strict regard to the subject. The handle at top, of constructive form, had entwined within it the initials of the General; his various decorations were arranged in a panel on obverse of lid, also in *champ-levé* enamel. Coats-of-arms, enamelled and enamel painted, occupied obverse and reverse of casket, while the ends were decorated respectively with views of the citadels of Cabul and Candahar; the architectural features treated with enamel lines after the mediæval manner. Trophies of Afghan and English arms, with suggestive symbols and Latin mottos, completed the decoration, while at the feet, of sound construction, dolphins were sporting. Mr. J. W. Benson had a distinct success in the casket made by him, as the City presentation to Sir Henry Bessemer. The figure of Invention, with the steel converter one side, and pigs of crude iron on the other, is sufficiently suggestive. The box is gold, a rich Renaissance, with bold decoration and twisted steel columns, while the plinth of steel, a *tour-de-force* of the inventor, is certainly realistic.

At this stage it will be convenient to refer to caskets which have ostensibly taken a distinct architectural character. The Italians of the 17th century were especially famous for caskets in iron, damascened in gold and silver. These caskets, of which a fine example is in the col-

lection of Earl Cadogan, partook of the character of the buildings of the period, being marked into divisions by pilasters or columns, having architectural mouldings and panels like window frames, so that the enamelled centres might almost serve for the stained glass. This style has reappeared in modern times, chiefly in caskets of a classical character. A notable example of this was the casket presented by the City to Mr. Gladstone, in 1882, and manufactured by the Goldsmiths' and Silversmiths' Company, of Regent-street. The severe lines of the box were suggested by the classic tastes of the then Premier; the centre trophy, of Mr. Gladstone's heraldic bearings, was approached on either side by a series of figures in gold against a field of blue enamel, which gave unity and symbolic value to the attributes represented. Four figures beyond the casket expressed qualities held to be exemplified in Mr. Gladstone's statesmanship, and the lid was elaborately decorated by emblems, in which the bust of Homer and the Lamp of Learning were conspicuous. *Punch* probably served the makers most, in regard to this casket, with humorous description, full of point, one of his sallies being to the effect that the Tuscan columns at the sides represented the columns led against the Government of the day by Mr. Parnell, on the one side, and Lord Randolph Churchill on the other.

An important casket of this class was produced by Messrs. Elkington, as a gift from the city of Athens to the Crown Prince of Greece, on the occasion of the attainment of his majority. It was designed under the direction of his Excellency M. Gennadius, Greek Minister at the Court of St. James. As a classic purist, he desired that it should represent the spirit of the famous city, and this was done with scrupulous accuracy of detail. On the lid are statuettes, the prince himself in centre. On the right, the city of Athens, presenting the address, while Pallas Athene, panoplied as of old, looks on approvingly. Altars of science and art respectively are at each side of the group. The "labarum" of Constantine is seen in front, with the arms of the ancient city. The box itself, having Corinthian columns at corners and ends, has a remarkable bas-relief. In centre, beneath a classic doorway round which is bending a growing laurel, in delicate compliment, the prince is seated. On either hand assemble the various provinces of Greece with messages of congratulation. Theseus, Achilles, Constantine, and Alexander each play their part in the design, and the surface, diversified with gold, silver, and rich enamels, gives the whole an effect of pure and balanced colour. Another casket, also by Messrs. Elkington, presented to the prince—this one by Greek residents in England—yet more emphasises the architectural idea. The figure work is elaborate and appropriate; not the least so being the panel where the Goddess of Wisdom, disguised as Mentor, is instructing the young prince in the duties of life and the art of wise administration. I must pass on to a casket from the same house, designed by an architect of Wigan, the motive being suggested by the ancient Town-house, supported on columns, a specimen of Early English construction. The arrangement is ingenious and decorative, the summit being crowned by a figure of the borough progress—based on coal—the miner's lamp indicating one stage, and the electric light the other.

In the year of Jubilee of Her Majesty's reign many caskets were presented, some retaining the architectural motive, while others were marked by much boldness and freedom. The one from the borough of Leamington, supplied by Mr. T. R. Roberts, in ivory and gold, was oblong in form, graceful in line, and the ornament agreeably disposed. A casket manufactured by Messrs. T. and J. Bragg, and presented to Mr. Peel, son of Sir Robert Peel, on the attainment of his majority in 1888, is a typical instance of an oblong box of ivory, decorated with gold and silver, following, in many respects, the traditions of the Middle Ages. The lid, rising in a gentle curve, is surmounted by a boldly modelled and enamelled blazon of the arms of the Peel and Tweeddale families; at the sides are enamelled portraits of Sir Robert and Lady Emily Peel, the father and mother of the recipient. Around central monograms, on obverse and reverse of lid, are *repoussé* panels, referring to agriculture, arts, and commerce. The motive of the design of the box is the family motto, "By Industry," and as a model by which it is gently suggested that the young man should shape his future career, a statuette of the great Sir Robert Peel, reduced from the statue in the market-place at Tamworth, is placed in a canopied arch in centre of casket. On either side of this, in gold frames, are enamel painted views—one of old Drayton Manor, the early home of the family, the other of the present mansion. The Tamworth arms and other relative subjects decorate remaining sides of the box; and the statuette of the great Prime Minister is saved

from apparent isolation by four other figures to same scale, occupying corners of the casket, having reference respectively to agriculture, the industrial arts, and wise and just legislation. Another casket, in gold and enamels upon a box of ivory, presented to the late Duchess of Sutherland by the ladies of Torquay, after a lengthened visit of the Princess of Wales and her three daughters to that charming place, was also manufactured by Messrs. T. and J. Bragg. It was oval, with arched ends, the lid raised up in several lines, the Princess's coronet surmounting it. The treatment was light and graceful, the leading features being four portraits, enamel painted on gold, of the Princess and her daughters, one forming the central motive on each side of the box.

We must not fail to describe the superb casket presented last year by the city to the Emperor of Germany, and manufactured by Messrs. Mappin Brothers. If anyone desired to form an idea of the extent to which the casket conception had developed during the past hundred years, it would be gathered by a comparison of the heart of oak box, or club snuff-box of a century ago, with this fine example of goldsmiths' work, which I will shortly describe. The style is that of the free Gothic of the Guildhall itself, which is adopted with brilliant effect, the open arches and tracery being shown against royal blue enamel, while the continuous borders and deep panels give a richness of colour quite remarkable. The shape is oblong, with semicircular bays at either end, the upper moulding is supported by a band of Gothic capital enrichment, and is crowned with a royal coronet border, similar to ancient boxes just referred to. A splendid feature at the base is a series of blazoned shields and ribands, giving the arms and names in a series of all the different kingdoms and duchies included in the German empire. Imperial eagles appear over the coronet rim; the arms of Germany occupy the centre; four emblematic figures in *repoussé* express the wishes of the City for the peace and progress of that empire, in fraternal union with England, and two interesting events connecting the two nations are displayed on the semi-circular bays. One is the marriage of our Queen with the late Prince Albert; the other the marriage of the late Emperor Frederick to the then Princess Royal of England. On the lid is the seated figure of the City of London, her mural crown being decorated with the wings of the dragon crest, a wealth of merchandise about her, the *caduceus* of commerce held aloft in the right hand, the City shield supporting her left.

In closing a description of various classes of address caskets, with which I hope I have not wearied you, let me remark that jewel caskets, as such, have followed much the same lines of change. The forms have become richer, bolder, and less conventional, not seldom, I fear, trespassing beyond the limits of the true rules of art. In gold, silver, damascened work, as well as in less costly materials, they vary so much that it is difficult to fix a modern classification. We may take two typical ones, both by the Messrs. Elkington. One, by M. Willms, is severe, classic in form, oblong, with pilasters at angles, and bas-relief in *repoussé*. One side represents a wedding procession, another the Athenian marriage ceremony. The doves of Venus and figure of Cupid on the lid, with the torch of Hymen, sufficiently indicate the object of the casket to be that of a bridal gift. The other low, long box, designed and modelled by the late M. Morel Ladeuil, is charmingly unconventional and free in treatment; while the placing of the figures to occupy the corners suggests the master hand.

I have finished my parable. It is a long stretch, from the first historic box overlaid with gold and containing sacred symbols, to the gold casket offered to an Emperor by the richest City in the world. There are many intervening stages, all of them interesting, although the most precious examples have been destroyed. The lessons they teach us are of patient art industry and laborious achievement. The works of the past bear no marks of haste upon them; their minute surface detail always speaks of leisure and reflection. In our modern days we have changed all that. Design, model, finished work, all must be completed in hot haste. What wonder if, in this rush and hurry, we lose something and forget much. The patient, loving care with which the artist of old could dwell on the minute parts of his design, the thoroughness with which he could adapt one part to another in those old days, gave him advantages which we are liable to miss in modern work. Knowing, as I do, the conditions under which large and elaborate presentation pieces are now got out, I do not marvel that they are not better; I often am surprised that they come through the race against time so well as they do. Partly for this reason, and still more because of the lack of art education among our workpeople, there is much modern work in this

class, which I prefer not to name. Pieces in which the decoration seems thrown together by accident, and in which different styles jostle each other, like fares in an omnibus—blatant vulgarities, that sin against every law of taste, and which are only remarkable for the unblushing audacity with which they violate the canons of art. These, unhappily are the products of 19th century competition.

Let us draw a veil over these infirmities, so far as the past is concerned, but let us, each in our own sphere, do something to provide against their prevalence in the future. First, let us educate our workmen, that they may be able to give the loving, artistic touch, and to afford the delicate sense of finish, which must add the final grace to the conception of the designer. Next, let us remember that a work of art must have time for its successful production. It is all very well for the contractor to tell us of five railway bridges being built in a fortnight. This is only a question as to how many men are needed to lay so many bricks, to cut and place so much stone. But, if you desire a work of art, and not a mere contract piece of no art value, you must give time for the hand, and heart, and brain of the artist to do their best upon it.

Again I would lift my voice against the miserable system of competition, which makes of what ought to be a work of art a mere race for advertising purposes, and often means a heavy fine upon the successful competitor for the privilege of putting his name to the piece. It is wonderful, under the conditions which often prevail, that great houses will be so public-spirited as to give so much real art at their own cost in important presentations; but surely it is not a healthy sign that they should be placed in such a position.

Lastly, may I add that it is well to guard against the rush for mere novelty of form in these caskets. The rage to secure a new shape often leads to most barbarous results, and while, I trust, I am the last to desire a dull and barren uniformity, I would remind my hearers that eccentricity is not always beauty, and that many a design which possessed excellent features has been incurably marred by a painful striving after some unheard-of effect. A beautiful design, whether of a casket or anything else, always has the virtue of repose. It appears brought together without effort, and you feel that you cannot take any part or ornament away without injuring the effect. Some caskets I have seen have hardly a single ornament which has a sustained attachment, and we might say of its decoration, remove it altogether. Unity of form and harmony of colour are most essential; and when to these are joined a sound conception, just construction, and artistic treatment of detail, we have the jewel and address casket, worthy of the knowledge and executive ability which, undoubtedly, exist among us.

With these remarks, and trusting to be favoured with the views of a Society which numbers among its members so many distinguished artists and experienced critics on a subject which is deeply interesting to me, I will now leave the paper in your hands.

DISCUSSION.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., having expressed his cordial thanks to Mr. Tonks for his kindness in preparing the elaborate and, historically, most instructive paper he had just read, said he had no special knowledge of its remarks on the primitive history of the casket. particular subject, and could only offer a few That was clearly revealed in India, where Hindu art to this day remained still hieratic and symbolical, and had, in none of its applications become secularised. It was evident to anyone who had been in India and studied the religious art of the Hindus, and the ideas it typified—ideas suggested by the frankest recognition of the more obvious physiological facts of our common human nature, the Divine and miraculous character of which has never become dimmed in their unjaded eyes—it was obvious to such a person that the casket of the myth of Pandora referred to woman herself as the human embodiment of the reproductive or maternal principle of nature. The story of the consecration of the young Nero's beard had a similar significance to the practice still prevalent in some parts of this country of stuffing a handful of hair, plucked from a new-born calf, into the left ear of its parent-cow. It symbolised the consecration of the first fruits of his adolescence to the maternal deities, *i.e.*, the reproductive principle, and thus symbolically realised his completed institution as a man. The first casket, universally, is woman; and the second is the place of human sepulture; a hollow tree, as still in Tasmania, or a portable ark of wood or metal, or a natural cave, or an excavated rock, or hole dug in the ground, or an earthenware jar, each and all symbolical of the mother* that bore the dead one into the light of life, and gradually of the resurrection of the body, the regeneration of the soul, and the everlasting life to come. The last, greatest, primitive casket was the shining frame of the heavens, bound in by the

* The hollow "Mother Tree," of popular superstition, and "Dame Holda's Tree of Germany," has frequently, in Europe, become transformed into a chapel to "Our Lady," the Blessed Virgin Mary of the Christian Church.

twelve signs of the zodiac. This was represented either of a cubical form, in which similitude of the heavens, the *Kaaba* at Mecca was designed, or sex-sept, oct, dec, or dodecagonal, or globular.* Caskets of the zodiacal type were still made in India and in Burmah, in which latter country indeed the primitive symbolism underlying Indian art could often be better studied than in India itself. Except that there were the twelve apostles for the twelve signs of the zodiac, and the four evangelists for the four guardians of the four quarters of the heavens, and an unmeaning finial to it, one of the caskets exhibited by Mr. Tonks might almost be said to be a direct transcript from a Burmese one sent to the Colonial Exhibition of 1886. It was surrounded by the twelve signs of the zodiac which stockade the universe, and was protected at the four corners by the four guardians of the four quarters of the heavens; while the lid was surmounted by a lotus bud, symbolising the generative or paternal principle of nature. Such a casket has exactly the same significance as the ark of the heavens, and the seven-nailed horse-shoe, which last represents the vault of space, with its seven active principles of life, *i.e.*, the seven planetary bodies known to the ancients. Similarly, the heavens have always been represented in the East by a seven-branched tree, a four-square city, a holy mountain, and a virgin mother; and we have all this imagery concentrated in the *Revelation of St. John the Divine*, and in a manner that seems directly suggested by decorative designs extant at the time it was written.† In India a Hindu woman's toilet-box always contains an iron symbol referring to her husband with very *naif* realism. These facts are clear indications of the primitive ideas that form the basis of all natural religion, and which permeated the pagan art of Greece and Rome, as they still permeate that of the Hindus. Everyone knew the etymology of the name of Delphi, and the significance of the Omphalos enshrined there; and to this day in India every hollow place is regarded as sacred to the divine mothers, and every hill to the divine forefathers of the human race. He would not attempt to criticise any of the modern caskets exhibited. They were beneath contempt. They violated every principle of utility and beauty, and made no pretence to express the primitive ideas and archaic myths that had first suggested them to the jewellers' art. It was an abuse of language to talk of them as illustrations of development from the mediæval examples lent for the illustration of Mr. Tonks' lecture by the South Kensington Museum, unless the word was to be understood in the sense also of retrogression and degradation. It was impossible to look at some of the more elaborate recent examples with any patience, and the manufacturers' self-complacent descriptions of them were enough to give one the nightmare.

Colonel LAMBERT agreed with the last speaker, that some modern specimens were more like nightmares than works of art; at the same time, he agreed with Mr. Tonks that you ought not to expect a manufacturer to put his hand in his pocket and produce an article worth twice or thrice that which he was to receive for it. It would be more satisfactory if the names of the designers of these boxes were associated with them rather than the names of those who sold them.

Mr. A. WYON said public competitions did a great deal to prevent the highest art being put into the work. It was manifestly unsatisfactory to give such small sums, when so many competed who got nothing at all for the artistic work they put into the competition.

Sir PHILIP MAGNUS said he had never been presented with a casket of any kind, and he had therefore no opportunity of studying the subject, but he had had the opportunity of seeing the very great interest which Mr. Tonks took in the production of artistic work in his own town, and was therefore attracted to hear this paper. He could not say anything about the caskets of the past or of the present, but he might say that those of the future would be much better than some of those of the present, if Mr. Tonks's ideas on art training were carried into effect. Mr. Tonks had taken a deep interest in the organisation of one of the most practical schools for improving art work, with which he was acquainted—the School for Goldsmiths' Work in Birmingham. Mainly, through his agency, two or three hundred young artisans were gathered together in a branch of the splendid Art School of Birmingham to learn the principles and practice of the art which specially applied to their own trade. They learned drawing, designing, and colouring, in their application to goldsmiths' work, and had the opportuuity of practising what they learned in the class in which chasing, enamelling, and mounting were also taught. He could not doubt that such splendid practical instruction would have a decided effect in improving the art work of the future.

Mr. LEWIS DAY said that, as he listened to the paper, and looked at such of the drawings of the old work as he could see from where he sat, he could not help thinking how impossible it would be to prevail on any 19th century committee to approve of any such design. There was great talk about improvement in art, and how it could be effected, but one of the

* The "Ciborium minus," or pyx, used in the Catholic Roman Church for holding the Blessed Sacrament, is directly derived from the *argha-patra* casket used in Hindu temples for holding the lapilliform *lingaw* of Siva; and from it are also derived the censer used in censing the images of Buddha in China and Japan, and the secular rose sprinkler used at ceremonial receptions by the Persians and Indian Mahomedans. See *Journal of Indian Art*, for October, 1891.

† It is almost certain that the "Throne of Satan," of the *Revelation of St. John the Divine*, refers to the "Great Altar," sculptured with "the Wars of the Giants," at Pergamon.

chief difficulties in the way was not merely the hurry and competition, to which Mr. Tonks had alluded, but the committee. The committee, he imagined, was a comparatively modern institution. It consisted, ordinarily, of a multitude of councillors, who seldom agreed on the choice of anything worth doing. He would express no opinion upon the modern designs exhibited, but, referring to the casket-shape, he considered the departure from the original cylindrical shape a departure from the right direction; if the thing was to contain a presentation roll, the square box was less appropriate than the cylinder, and the architectural design still less appropriate than the box. That was possibly not the fault of the designer altogether; they had to reckon with the committee; and what they wanted was not art, but a toy.

Mr. C. Purdon Clarke, C.I.E., said his views were so strongly in favour of the old caskets, that he would say nothing about the modern ones. One of the old ones shown that evening was exceedingly interesting, as they had been told, within the last few days, by a great authority, who had examined it closely in the Museum, that it was really of English manufacture; and they hoped to be able to trace its original owner, though probably the maker's name would remain unknown. Sometime ago Mr. Tonks asked him if there was any fixed shape for Indian jewel caskets, and he said they were invariably round; and this was, in the main, right. There were some boxes of an oblong form, but, as a rule, an Indian woman kept her jewels in a round box, generally stoutly made of brass, calculated to last a lifetime, with strong chain attachments, so that they might be fastened to the saddle in travelling. He had seen heavy chains on them in the North-Western Provinces. One of the caskets, made of basket work covered with heavy brass mounts, was very interesting; and there was another one of the same character, but about twice the size, in the Museum, which was well worth studying. It was curious, as showing how the most fragile material had been mounted with the same heavy metal mounts as would be used with strong wood or ivory.

Mr. H. Stannus said these meetings of the Applied Art Section of the Society were valuable, as giving an opportunity for the interchange of thought, and adding to the common stock of knowledge. He had been struck with Sir George Birdwood's remarks; and hoped to be able to preserve them in print. He felt it would be unbecoming in him to depreciate modern work, though he must say that he thought putting these examples of the old by the side of the modern did the modern work great disservice. In the design of a casket, the material was important. When it was wood or ivory—the wood being necessarily framed up, and the ivory in small pieces—straight forms were obviously the most perfect and suited to the material; but when using metal, which was fashioned chiefly by beating up a plate, curved forms appeared more suitable to the material. Hence a wood casket in a curved form, whether carved or plain, would be wrong; and on the other hand, a metal casket imitating the straight forms of wood was equally wrong in the other way. In one metal casket, anyone could see the lines were not perfectly straight, and they were not so good as they would be if the material were wood. The ornamentation was the next consideration; and this might arise from two main motives: either from the desire to make the object beautiful, or from the desire for storiation—a decoration which told a story. How could that be done? Taking one of the examples before him, there were the arms of England and the portrait of Her Majesty; the story told was that it probably belonged to her; and if one went further into the decoration, there was something showing the date at which the casket was produced, and the circumstances under which it was given to her. This was a most interesting question: whenever an artist had to design a casket, he should take care that the ornaments upon it should not be merely decorative, but that each should have reference to the purpose for which it was made. Heraldic badges were of use in this way; or, again, the design might have something connected with the local associations of the place. The casket represented in one of the photographs standing upon eight legs, very much astonished him, until he heard its origin; and then, when he found it was made for the town which had its old-fashioned Market-house supported on columns, he saw the local associations, and recognised its appropriateness. There were others, designed like Greek architectecture. He did not propose to enter into the question whether the imitation of architectural monuments was desirable; but, if it were so, anything to be presented to a Greek prince might be of Greek character. He thought also that a great distinction should be made between the two kinds of caskets dealt with. Mr. Tonks had spoken about jewel caskets and address caskets; but they were by no means the same thing. An address which was rolled up should be put in a casket which suggested the form of the roll, as Mr. Day had said, whereas jewellery was in small pieces, and would go in any convenient shape. All those which were shown might do for jewel caskets, but none suggested an address casket. Obviously, again, a jewel casket should suggest the idea of safety; but not one of these modern ones gave that idea. Some did not even show that they had a lid; and at the back, where the hinge should be, it had not been made a part of the artist's design. Every artist designing such a thing must realise the data before him. The drawings showed the front; but he wanted to see how the hinge and the lock were dealt with. Those were questions which appealed to the practical artists; but the committees, generally, did not think of them; they wanted plenty of gilding and enamelling, and a velvet stand for their money.

Mr. LONGDEN said he knew nothing about caskets, but he thought those made in recent years were not as well designed as they might be. It was quite possible he had not been much in the way of seeing them, but they usually appeared to be a heterogeneous mass of emblems set in a florid manner. But there had been one piece of work done—not a casket, but for presentation—within his memory, which showed how work might be done. Most probably those present had seen the piece of plate given by the Officers of the Army to the Queen on her jubilee. That was made by Mr. Alfred Gilbert, and any one who had seen that, and had seen the pure originality of the design, and understood the use of the materials and the way they were combined, would say that as good work as was done in old times could be done now, and would be done if the same means were taken. The means were to find the artist and go to him, not to an "eminent firm," but to an artist, and let him do it. Give him a commission, and do not have a competition amongst half a dozen artists.

The CHAIRMAN said he wished first to refer, for a few moments, to the specimens which had been taken out of the cases at the Museum for the purpose of illustrating the paper. That had been done because, at South Kensington, they looked on the Society of Arts as their parent, and he thought the Society had reason to be proud of such an offspring. The Museum had one of the finest collections in the world, and he was not the only one who said so, and that Society, which took such an interest in the first Exhibition of 1851, as it had in others since, had had a great deal to do with the formation and foundation of South Kensington. Therefore, it was that the authorities were quite justified in making an exception in favour of the parent society in lending these objects of interest, the more so, when they were illustrated in such a practical way, as they had been, by Mr. Tonks. He was very glad that Sir Philip Magnus had brought out the very valuable work which Mr. Tonks was doing in the teaching of workmen at Birmingham. He was a practical man, and also a modest man, or he would have said something more about himself. On the occasion of the Princess Beatrice's marriage, it was arranged that she should receive a fan, which had been painted for her by the students of the Royal Female School of Art; and it was supposed that this would have to be sent to Paris to be mounted; but that was so foreign to his ideas, that he obtained permission to send it to Birmingham, where it was mounted by Mr. Tonks; and he would back the mounting of that fan against any of modern times to be found in Paris. If Englishmen would only have some belief in themselves, and, instead of always going to Paris, would promote designing in England, which was dying out because it was not properly encouraged, it would be far better. It was a horrible mistake, when some of the best designers in the world were our own countrymen, that people should always go abroad to get their ideas carried out. It was not natural, and not patriotic; and he did hope the time would come, when manufacturers would believe in themselves, and in designs executed in this country. He concluded by proposing a hearty vote of thanks to Mr. Tonks.

The vote of thanks having been passed unanimously,

Mr. TONKS, in reply, said he was quite overcome by the kind expressions made use of in regard to him. It was a great delight to him to open this question, but he was conscious from the first that as soon as he began a subject which always had been discussed, and probably would be for many a long year, it would show the deep chasm which separated ancient and modern work. They had heard many times of their great disparity, and in some respects he must agree with many of the remarks made, but still, at the same time, they must regard the influences at work, and, above all, the conditions in which they lived. How far those conditions could be improved was one of the problems for the Art Section to consider, and in that direction the discussions might be useful. Many of their friends no doubt looked to the past with very longing eyes, especially to the simplicity and severity of form, and the delightful decoration, which was hardly likely to be seen again until the artist had such leisure given to him as was given to the artist in one particular piece which he had described; but, on the other hand, they had to consider Committees, and all those people who were concerned, and the education not only of workmen, but of the public in artistic matters. Taking these points into consideration, it required much delicacy in dealing with modern work, simply on the ground that the defects arose very often as much from the tastes of the Committee as from the persons who might produce it; probably more so. In speaking of some classes of criticism, he was reminded of the figures on one of the Hamilton vases. There was displayed a Victory presenting a winner at the Olympian games with a laurel wreath, but there was also a person at the back pulling a feather from the wing of Victory. He supposed that was the Greek way of representing detraction, and perhaps a moral might be drawn from that for modern times. Mr. Stannus had referred to "storiation," and with that was connected the element of symbolism. How far it should be applied they had yet to learn, but it was an important element in modern art which ought to be more considered. Sometimes the most beautiful pieces of art were absolutely lacking in anything except that æsthetic sense derived from the delightful treatment of detail. He was not sorry that the time had gone when these pieces would be accepted by the public or Committees, and while they might admire much mediæval art work it was painfully lacking in that particular symbolic value. Even with regard to that beautiful piece described by Mr. Longden, he could not avoid saying that

unfortunately it was the basest rococo, of which style he had a perfect horror. He hoped he should not be accused of any lack of appreciation for the extreme beauty of Mr. Gilbert's work. His memorial to Mr. Fawcett was one of the most beautiful pieces of metal-work which could be imagined, and was not at all subject to the criticism he had now made. He hoped that great artist would not waste his time upon that corrupt rococo style, but that he would bring his great powers to bear upon a style much more worthy of his genius. The Jewellers' Art and Technical School of Birmingham was certainly one which was doing great good; while, not only in jewellery, but in every other industry, the City Guilds Institute, of which Sir Philip Magnus was Director, by their system of technical examinations, were doing a great practical work. The artist must go through the work if it was to be thoroughly artistic. How could you get artistic work unless the workmen were artistic? We should never, he feared, get to a time when the artist could follow his own work right through with his own hands. In some cases, where a very large sum was given, it might be done, but only in a few, and for the hundreds and thousands who wanted works of art it was impossible for the designer to work them out. In that case the only chance of getting back to perfect detail was to have educated workmen, who should carry out the ideas of the designer. The artist, therefore, in his own interest, should look to have a body of trained art workmen who could sympathise with his views, and, in course of time, would be able to interpret them. It was only by a combination of this technical and art training that there could be any hope of seeing again anything like the glories of the Middle Ages with regard to artistic detail of work.

Mr. J. HUNTER DONALDSON writes:—In discussing the interesting paper upon caskets by Mr. J. W. Tonks, I do not think sufficient reference was made to the beautiful collection lent by South Kensington Museum to illustrate it; and although disparaging remarks were made upon modern caskets, the differences between those and the ancient ones were not pointed out. There being no time to speak upon it that evening, I ask permission to offer few remarks now. Probably every person present would have concurred in the opinion that in beauty of design, suitability to their use, execution and variety of materials, the ancient examples were altogether admirable; but it was noticeable that whilst hardly any of these were exclusively of metal the modern ones were little else. It does not seem to have occurred to committees selecting such works that great artists of the past thought ivory, decorated leather, wrought iron, carved wood, and even rich embroidery, might effectually be employed in caskets; that the forms should be well defined, not overladen with emblematic and other details, or the sizes too small for their purpose. Competition being happily unknown, there was no necessity for the hot haste incompatible with the production of really artistic work. Now, why should such works be hurried? The city of London, for example, from past experience, knows very well that, in a given time, its "freedom" will be presented to some personage, and the sum usually spent on the casket. Why should it not at once invite artists to send in designs, the three best being paid for? On one being chosen, tenders for making it could be invited, subject always to the work being supervised by the designer, who, being free to employ the materials best suited to his design, would have a much larger number of skilled men to select from than are at present obtainable amongst goldsmiths only. Let us get rid of the vulgar idea that the casket is to be valued for the gold it may contain, and think only of the art in it which has made the South Kensington ones precious for all time.

The paper was illustrated by a series of fine examples of old caskets selected from the South Kensington Museum, and lent by the Lords of the Committee of Council on Education, as well as by some specimens exhibited by Mr. Tonks.

TWELFTH ORDINARY MEETING.

Wednesday, March 2, 1892; Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Gough, Kedgwin E. K., 1, Overton-road, Brixton, S.W., and Board of Trade, S.W.
Grant, William, University College, Gower-street, W.C.
Kapp, Gisbert, 31, Parliament-street, S.W.
Legard, Colonel James D., 13, The Cliff, Scarborough.
MacLean, Robert Black, Woodville, Burghill-road, Sydenham, S.E.
Scorgie, James, Poona-vllla, King's-gate, Aberdeen.
Scott, Ernest, 3, Investment-buildings, 67, Lord-street, Liverpool.

The following candidates were balloted for and duly elected members of the Society;—

Ellis, Walter L. J., 30, St. John's-wood-road, N.W.
Herschel, Prof. Alexander Stewart, M.A., D.C.L., F.R.S., F.R.A.S., Observatory-house, Slough, Bucks.
Parsons, Hon. Richard Clere, Oak Lea, Wimbledon-park, Surrey.
Sturge, Edward Brockway, 20, The Waldrons, Croydon, Surrey.
Wollaston, Arthur N., C.I.E., India-office, S.W., and Glen-hill, Walmer, Kent.

The paper read was—

THE SPONTANEOUS IGNITION OF COAL, AND ITS PREVENTION.

By Vivian B. Lewes, F.I.C., F.C.S.,
Professor of Chemistry, Royal Naval College.

Last autumn I had the honour of bringing before the Chemical Section of the British Association certain views, which are now widely gaining ground, as to the cause of the phenomenon of spontaneous ignition in masses of stored coal; and, in the discussion which ensued, Sir Frederick Bramwell expressed the hope that the paper would be followed by a second, in which methods for the prevention of this too often disastrous action might be discussed; and it is at the invitation of your Secretary that I propose to bring my views on the subject before you to night.

Ever since the general adoption of coal as a fuel, the storing and shipment of masses exceeding 2,000 tons has been recognised as requiring great care; and if much small coal has been present, or if it has been stored wet, firing, or at any rate heating, of the mass, has frequently taken place. On shore this has led to much inconvenience, and loss, but it is during shipment that the real danger has occurred; and many a fine vessel, with all hands, has been lost from this cause, without even a record of the calamity reaching the land.

In 1875, the loss of life and property from this cause became so serious, that a Royal Commission was appointed to report upon the possibility of preventing these appalling disasters; but the recommendations contained in the report, although of the greatest possible value, seem to have had but little effect in checking the loss from spontaneous ignition; and, in the nine years following the publication of the report (1873 to 1883), no less than 57 coal-laden vessels are known to have been lost from this cause, whilst 328 others were missing.

In coal stores, and in gas works, heating frequently takes place, but is so much more easily dealt with than at sea, that cases of absolute ignition are much rarer; and it is from the evidence obtained in the case of coal cargoes, that we can learn most as to the cause and prevention of this most dire plague of the coal trade.

In treating the subject to-night, I will first bring to your notice the explanation of the action which eventually results in combustion, and which is founded upon the work of Richters and myself, and will consider how the incipient action can be best prevented, or at least retarded, and the steps which should be taken in case ignition should result.

Coal is a substance of purely vegetable origin, formed out of contact with air by long exposure to heat and pressure, from the woody fibre and resinous constituents of a monster vegetation, which flourished long before the earth was inhabited by man; and coal may therefore be looked upon as a form of charcoal, which, having been formed at a temperature lower than that of the charcoal burner's heap, and under great pressure, is very dense, and still retains a quantity of those constituents which, in the latter case, are driven off as tar, wood naphtha, &c. These bodies consist essentially of compounds containing carbon and hydrogen, together with a little oxygen and nitrogen, and form the volatile matter and hydrocarbons of the coal.

Besides the carbon and hydrocarbons, coal also contains certain mineral bodies, which were mostly present in the sap and fibre of the original vegetation, and which gives the ash which is left behind when the coal is burnt. These substances consist chiefly of sulphate of lime or gypsum, silica, and alumina, whilst in nearly all kinds of coal is to be found a substance called disulphide of iron, coal brasses, or pyrites, which has been formed by the gradual reduction of the sulphates by carbonaceous matter in the presence of iron salts, and which, during the combustion of the coal, is decomposed, giving off sulphur compounds, and leaving behind oxide of iron, which gives the reddish brown colour to the ash of many kinds of coal.

Of these constituents of coal, the only ones which play no part in the phenomena attending heating and spontaneous ignition, are the mineral constituents other than the pyrites, and we have, therefore, to deal with the chemical actions which take place when the carbon, hydrocarbons, and brasses contained in newly-won coal come in contact with air and moisture.

A.—The Influence of Carbon in Producing Heating.

Carbon is one of those substances which possess to an extraordinary degree the power of attracting and condensing gases upon their surface, this power varying with the state of division of the particular form of carbon used. The charcoal obtained from dense forms of wood, such as box, exhibits this property to a

high degree, one cubic inch of such charcoal absorbing:—*

Ammonia gas	90 cubic inches.
Sulphuretted hydrogen ..	55 ,,
Carbon dioxide	35 ,,
Ethylene (olefiant gas) ..	35 ,,
Oxygen	9·25 ,,
Nitrogen	6·5 ,,

whilst certain kinds of coal also exhibit the same power, although to a less degree.

The absorptive power of newly-won coal due to this surface attraction varies, but the least absorbent will take up one and a quarter times its own volume of oxygen, whilst in some coals more than three times their volume of the gas is absorbed. This absorption is very rapid at first, but gradually decreases, and is, moreover, influenced very much by temperature, for reasons which will be explained later.

The absorption is at first purely mechanical, and itself causes a rise of temperature, which, in the case of charcoal formed in closed retorts, as in preparing alder, willow, and dogwood charcoal for powder making, would produce spontaneous ignition if it were not placed in sealed cooling vessels for some days before exposure to air.

The rate of absorption varies with the amount of surface exposed, and, therefore, able to take part in this condensing action, so that, when coal or charcoal is finely powdered, the exposed surface being much greater, absorption becomes more rapid, and rise of temperature at once takes place. If, after it has been made, charcoal is kept for a day out of contact with air, and is then ground down into a powder, it will frequently fire after exposure to the air for thirty-six hours, whilst a heap of charcoal powder, of 100 bushels or more, will always ignite. It is for this reason that in making the charcoal for powder, it is always kept, after burning, for three or four days in air-tight cylinders before picking over, and ten days to a fortnight before it is ground.

In the case of coal, this rise in temperature tends to increase the rate of the action which is going on, but is rarely sufficient to bring about spontaneous ignition, only about one-third the amount of oxygen being absorbed by coal that is taken up by charcoal; the action also being much slower, tends to prevent the temperature reaching the high ignition point of the coal. Air-dry coal absorbs oxygen more quickly than wet coal.

* Saussure.

B.—The Action of the Bituminous Constituents of the Coal in Spontaneous Ignition.

All coal contains a certain per-centage of hydrogen, which is in combination with some of the carbon, and also with the nitrogen and oxygen, and forms with them the volatile matter in the coal. The amount present in this condition varies greatly, being very small in anthracite and very great in cannel and shale. When the carbon of the coal absorbs oxygen, the compressed gas becomes chemically very active, and soon commences to combine with the carbon and hydrogen of the bituminous portions, converting them into carbon dioxide and water vapour. This chemical activity increases rapidly with rise of temperature, so that the heat generated by the absorption of the oxygen causes it to rapidly enter into chemical combination. Chemical combination of this kind—*i.e.*, oxidation—is always accompanied by evolution of heat, and this further rise of temperature again increases rapidity of oxidation, so that a steady rise of temperature is set up, and this taking place in the centre of a heap of small coal, which, from the air and other gases enclosed in its interstices, is an admirable non-conductor of heat, will often cause such heating of the mass that, if air percolate slowly into the heap, in sufficient quantity to supply the necessary per-centage of oxygen for the continuance of the action, the igniting point of the coal will soon be reached.

The effect of rise of temperature in increasing the rapidity of chemical actions of this kind can be realised from the effect which it has in the spontaneous ignition of oily waste or rag.

If a substance like cotton waste be rendered oily with anything except the mineral oils, it acquires the power of taking up oxygen from the air, and this oxidising the oil gives rise to heat. At ordinary temperatures this oxidation is slow, and, consequently, it may be days before the rise in temperature becomes sensible, but when this point is reached the oxidation proceeds with remarkable rapidity, and in a few hours the point of ignition is reached, and the mass bursts into flame, whilst if the oily waste be placed in a warm place at first, spontaneous ignition is only a question of hours, or sometimes even minutes.

Galletley found that oily cotton at ordinary temperatures took some days to heat and ignite, whilst, if placed in a chamber warmed to 130° to 170°F. (54° to 76°C.), the cotton, greasy

with boiled linseed, ignited in one hour fifteen minutes, and olive oil on cotton in five hours; and in a chamber heated to 180° to 200°F. (82° to 93°C.) olive oil on cotton ignited in two hours.

It has been suggested that very bituminous coal, such as cannel, shale, and coals containing schist, is liable to spontaneous ignition from the fact that a rise in temperature would cause heavy oils to exude from them, which, by undergoing oxidation, might cause rapid heating. But experiment not only shows that this is not the case, but that the heavy mineral oils have a remarkable influence in retarding heating; cotton waste, oily with easily oxidisable oils mixed with 20 per cent. of heavy mineral oil, being exempt from heating.

C.—The Action of Iron Disulphide, Pyrites, or Coal Brasses in Promoting Spontaneous Ignition.

The earliest theory as to the cause of spontaneous ignition in coal was, that it was due to the heat given out during the oxidation of pyrites (the disulphide of iron) into sulphates, and this idea has been adopted, and has held its own, in this country up to the present time, although the researches of Dr. Richters, some twenty years ago, clearly prove that the explanation was an erroneous one, and the late Dr. Percy, as early as 1864, pointed out that probably oxidation of the coal had a great deal to do with the action.

This disulphide of iron is found in coal in several different forms, sometimes as a dark powder distributed throughout the mass of the coal, and scarcely to be distinguished from coal itself. In larger quantities, it is often found forming thin golden-looking layers in the cleavage of the coal, while it sometimes occurs as masses and veins, often an inch or two inches in thickness, but inasmuch as these masses of pyrites are very heavy, they rarely find their way into the screened coal for shipment, many hundreds of tons of these "brasses" being annually picked out from the coal at the pit's mouth, and utilised in various manufacturing processes.

The yellow pyrites which form the large masses in the coal, and even the dark varieties when in the crystalline form, remain practically unaltered, even after long exposure to moist air, but the amorphous and finely divided portions, which probably contain lower sulphides mixed with the disulphide, will oxidise and effloresce with considerable rapidity when exposed to moisture and air, forming mixtures of ferrous sulphate and basic sulphates of iron, and it is during this process of oxidation that the heat supposed to bring about the ignition of the coal is generated.

In some of the coals most prone to spontaneous ignition there is only 0·8 per cent. of pyrites, and if we imagined the whole of this to be easily oxidisable, and to be concentrated in one spot instead of being spread throughout the mass, and to be entirely oxidised in a few hours, the rise of temperature would only be a few degrees; whereas, under existing circumstances, it is manifest that practically no determinable increase can be generated by the action.

Under certain conditions the oxidation of masses of pyrites first gives rise to the formation of ferrous sulphate, and sulphur dioxide with liberation of sulphur, and my early experiments led me to believe that inasmuch as sulphur has an igniting point of 250° C., this free sulphur might play an important part in the action, by lowering the point of ignition; later experiments, however, show that this could only take place with large masses of pyrites undergoing oxidation, and that with the amounts present in coal, if the air were present in sufficient quantity to oxidise the pyrites, the small trace of sulphur liberated would be oxidised to sulphur dioxide at temperatures as low as 60° C. This oxidation of sulphur at low temperatures is not a generally known action, but my experiments show that it takes place with considerable rapidity. The only way in which pyrites can assist spontaneous ignition is that when they oxidise they swell, and cause disintegration of the lumps of coal, so exposing fresh surfaces to absorb oxygen and afterwards carry on chemical action.

I have carefully determined the igniting point of various kinds of coal, and find that—

Cannel coal	ignites at	698	deg. F.	= 370	deg. C.
Hartlepool coal	,,	766	,,	= 408	,,
Lignite	,, ,,	842	,,	= 450	,,
Welsh steam coal	,,	870·5	,,	= 477	,,

So that no stretch of imagination could endow the small trace of pyrites scattered through a large mass of coal, and undergoing slow oxidation, with the power of reaching the needful temperature.

When coal is heating, it gives out a distinctive and penetrating odour, which is the same as that noticed when wood is scorched. The gases evolved by the heating coal consist of nitrogen, water-vapour, carbon dioxide,

carbon monoxide, hydrocarbons of the paraffin series, and sulphuretted hydrogen, the presence of the latter gas showing beyond doubt that oxidation of sulphur had nothing to do with the action.

We can now trace the actions which cumulate in ignition. The newly-won coal is brought to the mouth of the pit, and at once commences, by virtue of its surface action, to absorb oxygen from the air; but unless piled in unusually large heaps, and a great deal broken, it does not, as a rule, show signs of heating, as the exposed surface is comparatively small, and the air finding its way freely between the lumps keeps down the temperature. The coal is now screened, and the obtrusively large lumps of brasses picked out; it is then put in the trucks, and enjoys the disintegrating processes of joltings and shuntings innumerable, every jar adding to the per-centage of small coal present, and a corresponding increase in the size of the surface exposed to the air. Arrived at the docks, it has to be transferred from the truck to the ship, which is done by one of the numerous forms of tips, shoots, or spouts employed for the purpose, and it is during this operation that more harm is done than at any other period. The coal first shot into the vessel, by reason of the distance which it has to fall, is broken down into small lumps, and having to bear the impact of the succeeding load falling upon it from a height, rapidly becomes powdered into slack, whilst the succeeding loads falling in on the cone so formed get more or less broken down, so that, by the time the cargo is all taken in, a dense mass of small coal is to be found under the hatchway, and it is invariably at this point that heating takes place, as the large surface exposed fresh to the air by the breaking down of the coal causes rapid absorption of oxygen, and consequent rise of temperature. This sets up chemical combination between the oxygen absorbed by the coal and the hydro-carbons and coal brasses.

On examining the evidence to be obtained as to the conditions under which spontaneous ignition of coal in ships usually takes place, it is found that liability to ignition increases with:—

1. *The increase in mass of coal.*—Thus, in cargoes of under 500 tons the cases reported amount to a little under ½ per cent. for shipments out of Europe; from 500 to 1,000 tons, to over 1 per cent.; from 1,000 to 1,500 tons, to 3·5 per cent.; 1,500 to 2,000 tons, to 4·5 per cent.; and over 2,000 tons to no less than 9 per cent. The evidence demonstrating this very remarkable result is to be found in the Report of the Royal Commission for 1875, p. 8, and clearly shows the influence of mass upon this action, which acts in two ways:—(*a*) The larger the mass, the more non-conducting material will there be between the spot at which heating is taking place and the cooling influence of the outer air. (*b*) The larger the mass the greater will be the breaking-down action of the impact of coal coming down the shoot upon the portions first loaded into the ship, and the larger, therefore, the fresh surface exposed to the action of the air.

2. *The ports to which shipments are made.*—26,631 shipments to European ports, in 1873, only resulting in ten casualties, whilst 4,485 shipments to Asia, Africa, and America gave no less than sixty. This startling result is partly due to the length of time the cargo is in the vessel, the absorption and oxidation being a comparatively long action; but a far more active cause is the increase in the action brought about by the increase of temperature in the tropics, which converts a slow action into a rapid one, and if statistics had been taken, most of the ships would have been found to have developed active combustion somewhere about the neighbourhood of the Cape, the action developed in the tropics having raised the temperature to the igniting point of the coal by that time.

3. *The kind of coal,* some coals being specially liable to spontaneous heating and ignition. This is a point on which great diversity of opinion exists, but I think it will be pretty generally admitted that cases of heating and ignition are more frequent in coals from East Coast ports than in shipments of the South Wales coals.

The idea that the per-centage of pyrites present is any indication of the liability to spontaneous combustion, must be entirely discarded, as experiment shows that many coals poor in pyrites frequently ignite, whilst others rich in them are perfectly safe.

A much surer guide is to be found in the quantity of moisture present in an air-dried sample of coal, which is a sure index to the absorptive power. The higher the amount of moisture held by the coal, after exposure for some time to dry air, the greater will be its power of absorption for oxygen, and the greater therefore its liability to spontaneous heating and ignition.

This is beautifully shown by the following Table, in which the per-centage of pyrites and

moisture present in some coals are contrasted with their liability to self-ignition:—

Liability to Spontaneous Ignition.	Pyrites per cent.	Moisture per cent.
Very slight	1·13	2·54
	1·01 to 3·04	2·75
	1·51	3·90
Medium	1·20	4·50
	1·08	4·55
	1·15	4·75
Great	1·12	4·85
	0·83	5·30
	0·84	5·52
	1·00	9·01

The per-centage of moisture shown in this Table is not due to external wetting, but is moisture absorbed from the air and held by the coal, so that the amount of it present is an indication of the power of absorption possessed by the coal, and which will give it the power of taking up oxygen as well as water vapour.

4. *The size of the coal*, small coal being much more liable to spontaneous ignition than large. This, as has been pointed out, being entirely due to the increase in active absorbent surface exposed to the air, a fact which is verified by the experience of large consumers of coal on land; gas managers recognising the fact that coal which has been stamped down or shaken down during storage being more liable to heat than if it has been more tenderly handled, the extra breakage causing the extra risk.

5. *Shipping or storing coals while wet.*—The effect of moisture upon coal is very remarkable. At first external wetting retards the absorption of oxygen by the coal, but the presence of moisture afterwards increases the action of the already absorbed oxygen upon the hydrocarbons of the coal, and so causes a serious increase in the heating. Of late years the researches of Cowper, Baker, Dixon and others have shown so fully the important part which moisture plays in chemical combination, that it is now fully recognised as a factor of importance in actions of this kind. During last autumn, a very marked case of the influence of moisture in the action taking place came under my notice:—A ship took in a cargo of coal at a South Welsh port, the weather being fine and dry whilst she was loading at the main hatch, and wet whilst taking in the coal at the after hatch, with the result that the temperature after the first few days was uniformly about 10° higher in the coal that had been loaded wet than in the dry portion of the cargo, spontaneous ignition being the ultimate result.

6. *Ventilation of the mass of coal.*—The so-called ventilation, which has from time to time been introduced into coal ships, is undoubtedly one of the most prolific causes of spontaneous ignition. For ventilation to do any good, cool air would have to sweep continuously and freely through every part of the cargo, a condition impossible to attain, whilst anything short of that only increases the danger, the ordinary methods of ventilation supplying just about the right amount of air to create the maximum amount of heating. The reason of this is clear. A steam coal absorbs about twice its own volume of oxygen, and takes about ten days to do it under favourable conditions, and it is this oxygen which, in the next phase of the action, enters into chemical combination, and causes the serious heating. A ton of steam coal occupies 42 to 43 cubic feet, and if properly loaded contains between the lumps, as nearly as possible, 12 cubic feet of air space, that is to say, of the 42 cubic feet 12 cubic feet is air, and 30 cubic feet is coal. Thirty cubic feet of coal, with its fresh absorbing surfaces laid bare by the crushing incidental to loading, will, in the first ten days after being taken on board, absorb 60 cubic feet of oxygen, if it can get it. Now, air contains only, roughly, one-fifth of its volume of oxygen, so that 60 cubic feet represent 300 cubic feet of air, or twenty-five times as much as is present. It is therefore evident that if air could be excluded, there would be only one twenty-fifth the quantity of oxygen present that is needed for complete action, and any heating would, in consequence, be very slight; whilst to produce the greatest heating it would be necessary to change the entire air in the cargo twenty-five times in the first ten days, and this is just about what the old method of taking a box shaft along the keelson with venetian lattice upshafts from it would give.

The most forcible illustration of the evil of such ventilation is to be found in the case of the four colliers, *Euxine*, *Oliver Cromwell*, *Calcutta*, and *Corah*, which were loaded at Newcastle under the same tips, at the same time, with the same coal, from the same seam. The first three were bound for Aden, and were all ventilated. The *Corah* was bound for Bombay, and was not ventilated. The three

thoroughly ventilated ships were totally lost from spontaneous ignition of their cargo, whilst the *Corah* reached Bombay in perfect safety.

7. *Rise in Temperature.*—It has been fully pointed out that anything which tends to increase of initial temperature increases the rapidity of chemical action, and in most cases of spontaneous combustion in coals stored in this country, the cause can be traced to a steam pipe or boiler-flue in contact with the mass of coal, or even fixed to a wall against which, on the other side, the coal is heaped. Sometimes the coal store is close to the benches of retorts in a gas works, or even against the wall of the benches, and in such cases, with certain classes of coals, ignition would be almost certain to take place. In a paper read at the last meeting of the Gas Institute, it was proposed to lead the flues from the benches under the coal store, in order to dry the coal, a device which would infallibly lead to spontaneous ignition.

On colliers there are many causes for increased temperature, amongst them being the introduction of triple expansion engines and high-pressure boilers. Steam at 80 lbs. boiler pressure has a temperature of 324° F. (162° C.), and a common stoke-hold temperature, with boilers worked at this pressure, is 100° to 130° F. (or 38° to 54° C.) Steam at a boiler pressure of 155 lbs. has a temperature of 368° F., or 186° C., and gives a corresponding increase of temperature in the stoke-hold and other adjacent portions of the vessel, the temperature in the stoke-hold under these conditions being from 110° F. (43·5° C.) to 140° F. (60° C.), an increase of about 10° F.

Then, again, donkey boilers will often be found recessed into bunker bulkheads, and steam pipes led alongside the bulkheads, with the cargo close up against them on the other side. The effect of temperature due to climatic influences has already been dealt with under the influence on ignition of ports to which shipments are made.

Having now discussed the chemical and physical conditions which lead to the phenomenon known as "spontaneous ignition," we can formulate precautions which will tend to prevent such disasters.

1. *The choice of coal for storage or shipment.*—The coal should be as large as possible, free from dust, and with as little "smalls" as can be helped. It is better as free from pyrites as possible, and it should contain, when air-dried, not more than 3 per cent. of moisture.

2. *Precautions to be taken in storing or loading.*—The coal store should be well roofed in, and have an iron floor bedded in cement, all supports passing through and in contact with the coal should be of iron or brick; if hollow iron supports are used, they should be cast solid with cement. The coal must never be loaded or stored during wet weather, and the depth of coal in the store should not exceed eight feet, and should only be six where possible. Under no condition must a steam or exhaust pipe or flue be allowed in or near any wall of the store, nor must the store be within twenty feet of any boiler, furnace, or bench of retorts. No coal should be stored or shipped to distant ports until at least a month has elapsed since it was brought to the surface. Every care should be taken during loading or storing to prevent breaking or crushing of the coal, and on no account must a large accumulation of small coal be allowed. These precautions, if properly carried out, would amply suffice to entirely do away with spontaneous ignition in stored coal on land, and we have now to consider a far more important phase of the question.

3. *Precautions to be taken on board coal-laden ships.*—This phase of the question is undoubtedly the most important, and in order to ensure any successful treatment of the coal cargo at sea, to prevent undue heating and ignition, the means adopted must be as nearly automatic in their working as possible, as it is useless to expect the master or any officer on board a collier during rough weather, &c., to comply with any instructions, such as daily taking the temperatures in various parts of the cargo, and so on.

The iron bulkheads dividing the coal storage from the other parts of the vessel should be made double, and spaced six inches to a foot apart, with openings (which could be closed water-tight) every few feet, to allow of the interior being from time to time coated with protective compositions. Through this double casing sea-water would be allowed to circulate, and would not only effectually prevent any penetration of heat from the stoke-hold, boilers, or engine-room to the coal, but also do away with any chance of leakage of gases from the coal cargo into other portions of the vessel, and so would minimise the danger of explosions.

A similar double partition should run down the centre of that portion of the vessel in which the coal was stored, and it would be sufficient

if this were packed with silicate wool; this partition would serve to prevent any heating which might take place in one part of the cargo being communicated to the other half, whilst it would also perform the important function of helping to prevent shifting of the cargo during heavy rolling.

When the coal has all been taken in, it should be battened down, and the hatches should not be again opened until the vessel reaches her destination, the only ventilation allowable being a 2-inch pipe just inserted into the crown of each coal compartment, and led twelve feet up the nearest mast, the top being left open. This would be quite sufficient to allow free egress to any gases evolved by the coal, but would not allow undue excess of air.

Into the body of the coal cargo itself would be screwed, at regular intervals of about 10 feet, iron pipes, closed at the bottom, and containing alarm thermostats, so arranged that when a rise of temperature causes expansion of the mercury in rising in the tube, it makes a contact; and the wires from these tubes are in connection with an electric bell, index-board, and battery in the captain's room; so that the moment the temperature is reached to which the thermometers have been set the bell rings, and will continue to ring, until the temperature again sinks, the spot in which heating is taking place being indicated by the index-board.

In the evidence given before the Commissioners in 1875, Mr. J. Glover strongly advocated the use of carbon dioxide, or carbonic acid gas, as it is more usually termed, for extinguishing ignition when it had broken out in a coal cargo, and for stopping heating when it had reached a dangerous pitch. His proposal was to generate the gas by the action of hydrochloric acid upon chalk, and to lead it by gas pipes to the compartment affected; and this gas, being heavier than air, and a non-supporter of combustion, was to displace the air and its contained oxygen, and so to prevent further action by surrounding the coal with an atmosphere which could not carry on combustion. The idea was a good one, but there were many difficulties in the way of carrying it out, one being that, for every 1,000 tons of coal carried, 80 cwt. of hydrochloric acid would have had to be shipped; also the gas could not have been driven down into the hold if any serious heating had taken place, as an up-current would have been formed, and would have carried it away; whilst in the state of gas, it fails to give any great cooling effect, and so would have exercised but little influence upon the mass of red-hot fuel. These objections weighed so strongly with the Commissioners that, in their final report, we find the following sentences:—

"Several methods for generating carbonic acid gas, and applying it to the ignited portion of a coal cargo, have been proposed for our consideration. We consider, however, that although this gas might be useful for excluding atmospheric air (which is essential to support combustion), yet it will not, as water does, exert any very sensible cooling effect, *which is a point of vital importance in the case of a mass of ignited coal.* We are of opinion that water and steam are the only agents practically available for the purpose of extinguishing fire in coal cargoes."

Applied in the way which was suggested, there is no doubt but that the carbonic acid gas would have been practically useless; but there is another way in which it could be used, which would make it a most powerful cooling agent, an instantaneous quencher of fire, and would prevent any further tendency to heat on the part of the coal treated with it.

If carbonic acid gas is compressed under a pressure of 36 atmospheres at a temperature of 32° F. (0° C.), it is condensed to the liquid state, and can be obtained in steel vessels closed with screw valves. On opening the valve some of the liquid is ejected into the air, and, in coming into the ordinary atmospheric pressure, is in a moment converted into a large volume of gas. Conversion from the liquid to the gaseous state means the absorption of a large amount of heat; and so great is this, that everything near the stream of new-born gas is cooled down, and some of the escaping liquid is frozen to a solid, having a temperature of - 78 C., or - 108·4 F.

This liquid carbonic acid gas is now extensively manufactured, and is used abroad to a large extent for aërating waters, driving torpedoes, and for freezing machines; and I should suggest its use in the following way for the checking of ignition in the coal cargo:—

The nozzle attached to the screw-valve on the bottle of condensed gas should have a short metal nose-piece screwed on to it, the tube in which should be cast in solid, with an alloy of tin, lead, bismuth and cadmium, which can be so made as to melt at exactly 200° F. (93° C.). The valve should then be opened, and the steel bottle buried in the coal during the process of loading. The temperature at which the fusible metal plug will melt is well above the temperature which could be reached by any legitimate cause, and would mean that active heating was

going on in the coal; and under these conditions the pressure in the steel cylinder would have reached something like 1,700 lbs., and the moment the plug melted the whole contents of the bottle would be blown out of it into the surrounding coal, producing a large zone of intense cold, and cooling the surrounding mass to a comparatively low temperature. The action, moreover, would not stop here, as the cold, heavy gas would remain for some time in contact with the coal, diffusion taking place but slowly through the small exit pipe.

When the coal has absorbed as much oxygen as it can, it still retains the power of absorbing a considerable volume of carbonic acid gas; and when coal has heated, and then been rapidly quenched, the amount of gas so absorbed is very large indeed, and the inert gas so taken up remains in the pores of the coal, and prevents any further tendency of heating; indeed, a coal which has once heated, if only to a slight degree, and has then cooled down, is perfectly harmless, and will not heat a second time. It is not by any means necessary to replace the whole of the air in the interstices of the coal with the gas, as a long series of experiments show that 60 per cent. of carbonic acid gas prevents the ignition of the most pyrophoric substances.

One hundred cubic feet of gas can be condensed in the liquid state in a steel cylinder one foot long and three inches diameter, and it has been shown that a ton of coal contains air spaces equal to about 12 cubic feet; therefore, one of these cylinders would have to be put in for every eight tons of coal, as, although the gas formed at the first moment would only occupy a small space, on account of its low temperature, it would rapidly expand in contact with the hot coal. These cylinders should be distributed evenly throughout the cargo, and near the alarm thermometers, which should be set to ring a degree or two below the point at which the fusible plug would melt.

The bell ringing in the captain's room would warn him that heating was taking place, and the bell would continue to ring until the cylinder had discharged its contents, and had cooled the cargo down to a safe degree, so that the whole arrangement would be purely automatic, and yet the officers would know if everything was safe.

This liquid is now being made at a comparatively cheap rate, and, with any demand for it, machinery could be put up at the principal coaling ports, to charge empty cylinders at a very low rate, so that the initial cost of the steel cylinders once got over, the expenses would not be worth considering, more especially as one, or two at most, of the cylinders in use, would be likely to go off.

If the precautions advocated were taken, on danger could arise until the arrival of the ship at her destination, and the commonest precautions would then suffice. On removing the hatches no naked light must be allowed near them, and no one must be allowed to descend into the hold until all the gases have had time to diffuse out into the air. If the cylinders have gone off, there will be but little fear of explosion, as a high per-centage of the carbonic acid gas lowers the explosive power which the mixture of marsh gas (given off from some coal) and air possess; but the carbonic acid gas would overcome and suffocate a man descending into an atmosphere containing any considerable per-centage of it. When a safety lamp, lowered into the hold, continues to burn as brightly as it did in the open air, then it is perfectly safe to descend.

When once coal in a cargo has fired, pumping in water is of practically no use, as the fire is, as a rule, near the bottom of the mass of coal, and the flow of the water is so impeded by the caking of the heated mass above the fire, that in percolating through the interstices of the heated coal, it is converted into steam before it can reach the seat of combustion. The most effective way to apply water would be to have three-inch pipes laid along the floor of the coal compartments, about six feet apart, these tubes having a quarter-inch hole bored in the upper side every foot or so, and each pair of pipes coming through the bulk-head, and connecting on to two six-inch pipes passing through the side of the vessel, the sea water being prevented from entering by means of screw valves. As soon as the alarm thermometer gave notice that heating had reached a dangerous point, these valves could be opened and the lower portion of the cargo drenched with salt water. This, evaporating rapidly, would give large volumes of water vapour, which, passing up through the heated coal, would lower its temperature, but would not be nearly as effective as the method before advocated. It might, however, be used in conjunction with that method, and would, in many cases, save the carbonic acid gas.

In the case of coal bunkers in modern steamers and warships, the conditions under which the coal is placed are so totally different from those existing in a collier, that no comparison can be drawn between them.

In the coal bunker, the question of mass,

which plays so important a part in a hold laden with coal, is almost entirely eliminated, as 50 to 400 tons would be about the capacity of any ordinary bunker, and it has been before shown that the cases of spontaneous ignition in masses of coal less than 500 tons does not amount to more than quarter per cent., and the question of initial temperature becomes the most important factor.

A few years ago, such an occurrence as a coal bunker on fire was rare, whilst at the present time hardly a week passes without some more or less serious cases occurring on the fast liners, and it is evident that there must exist some well-defined cause for this enormous increase in cases of spontaneous ignition. On collecting evidence on this point, the first thing that strikes one is that bunker fires are almost entirely confined to vessels in which the bunker bulkheads are only separated from the funnel by a narrow air-space, or in close proximity to the boilers themselves, but where the bunkers are stepped back from the funnel casing and boilers, spontaneous ignition is a great rarity.

Taking the case of a fast liner, it is found that the temperature in a coal bunker varies very considerably, according to its proximity to the air channel round the funnel casing. Close to the outside of the bulkhead the temperature is often as high as 200° F. (93° C.) whilst inside 120° would be a fair estimate, and from the centre of the bunker to the side of the vessel it is seldom above 75°F (24° C.); the temperature, however, being higher near the iron decks, which, being in contact with the heated bulkhead, conduct the heat through the coal, and raise the temperature often up to 100° F.

It has been pointed out that if coal be kept at a high temperature, even though it be far below its igniting point, ignition is only a question of time; and if the bunker coal next the bulkhead be kept at 120° F., any coal with a tendency to absorb oxygen will run a great chance of igniting within a few days. It is manifest that if this is the real cause of ignition, the seat of the fire ought to be found close to the heated bulkhead, but this is very often not the case, the mass of fire being found near the centre of the bunker, and sometimes even towards the sides of the vessel; but careful examination soon reveals the cause of this, as a line of charred coal is mostly to be found running from the heated bulkhead to the seat of active combustion, showing that the fire started by the high initial temperature has not had sufficient air near the bulkhead to do more than smoulder, but that as soon as it came in contact with a current of air passing up through the coal from the hatches in the decks, the smouldering mass began to burn fiercely.

In order to prevent spontaneous ignition of the coal under these circumstances, all that is necessary is to reduce the temperature of the bulkhead in contact with the coal, as if this is kept at a temperature not exceeding 82° to 90° F., there is little or no fear of the oxidation of the hydrocarbons of the coal proceeding with such rapidity as to cause ignition in such a quantity of coal as can be carried in the bunkers; the iron decks, by subdividing the mass, also helping to reduce any risk.

In order to reduce the temperature to the required extent, it would be necessary to make the bulkheads close to any heating surface, such as the funnel casing, double.

Through this double casing sea-water would be allowed to circulate very slowly, and would effectually prevent any undue rise of temperature; whilst, to make the arrangements complete, a thermostat should be fixed on the inner plate of each bulkhead, which, if the temperature rose to 100° F. (38° C.), would ring a bell in the captain's room, when the rate of flow of water could be increased until the required fall in temperature took place.

Should this arrangement prove impossible from any structural cause, then a rapid current of air forced through the bunkers by means of a fan, or even an up-current formed by a good air-pump ventilator in the crown of the bunker, would go far to keep the temperature within safe limits.

In a coal cargo, perfect ventilation is impossible on account of the mass of coal present, and, therefore, the hold should be battened down, and everything done to prevent imperfect ventilation, gas-tight bulkheads being a necessity for this purpose.

In coal bunkers, on the other hand, on account of free access being obtained to both top and bottom of the coal, and also the small mass present, perfect ventilation is possible, and should be attempted, whilst the water bulkheads will do away with any undue rise of temperature.

Chemists have been repeatedly asked if analysis gives no indications by which a coal, liable to spontaneous heating, can be distinguished from another which is perfectly safe for storage or shipment in bulk; but, up to the present time, the action has been so little understood, that no such differentiation was

possible, but with a clear conception of the causes which lead to heating, it should be quite possible to do so.

As I have shown, all coals, when heated to a temperature a little above that of boiling water, have their power of absorbing oxygen so increased that they will, in a few hours, absorb sufficient to give a perceptible increase in weight, and the greater their absorption power the greater will the increase be; and as it is upon this that the liability to heat depends, the amount of increase in weight would give a sure indication of the liability to spontaneous ignition. We have at present, however, no data to show what is a safe amount of absorption and with what amount danger commences, and the owners of collieries yielding coal liable to heating are so anxious to prevent the fact leaking out, that there will be considerable difficulty in obtaining authentic samples to make the determination with.

My own experience, however, leads me to think that if an air-dry coal does not contain more than 3 per cent. of moisture, and when powdered and heated to about 250° Fahr. in an oven for three hours does not increase more than about 2 per cent. in weight, it may be looked upon as a safe coal to store in bulk.

I am perfectly aware that the precautions I have suggested will never, unless pressure is brought to bear upon them, be adopted by the owners of colliers, on account of the slight extra expense and trouble they would involve; but if Lloyds could be prevailed upon to lower the rate of insurance upon coal cargoes treated in this way, and substantially increase the rate upon cargoes in which these precautions had not been adopted, a class of disaster as appalling in nature as it is destructive in result would soon be entirely done away with.

DISCUSSION.

Sir James Douglass, F.R.S., desired to thank Professor Lewes for what he had done in the way of providing a way of safety for those who had to convey coal to distant parts. The method proposed certainly seemed a little troublesome to shipowners, but it was not very expensive; and if it ensured safety to coal ships, as it seemed to do, it ought to be adopted. He hoped Lloyds would see their way to encourage owners to adopt these necessary precautions. He should certainly urge the adoption of the necessary precautions with regard to the storing of coal in bunkers in any case he had to deal with.

Mr. Francis Cobb thought if the attention of Lloyds were drawn to this paper, underwriters would very speedily fall in with the suggestion that properly protected ships should be insured at lower premiums than those which were not; and he should be glad if means were taken to distribute the paper amongst those interested. Up to the present it appeared that most people had been acting under a grave misapprehension. Considerable expense had been incurred in ventilating coal ships, especially those going to the west coast of America and the East Indies, and now it appeared that this was a step in the wrong direction. He knew of one case where an old American captain refused to have any ventilation, as he was loading his vessel for the west coast of America, and a fine iron ship alongside of him was ventilated at great expense; but in the end the old wooden ship delivered her cargo cool and in good condition, while the fine English ship was burned. The one captain closed his hatches as quickly as possible, and never opened them again till he got to his destination, whilst the other put up wind-sails to blow air right through the cargo, which, at that time, they had been taught was the proper thing to do. If anything could be devised by which the liquid carbonic acid could be used without having a bottle for every eight tons of coal, which seemed to him impracticable, it would no doubt be very useful. If it could be carried in larger bulk, and distributed where it was required, there would be no difficulty in fitting ships to carry it.

Mr. W. E. Stanley Thomson said he had been favoured by Professor Lewes with an early copy of the paper, and had had communications from him before, and he had therefore taken the trouble to make himself acquainted with the results of the inquiries which had been held since the report of the Commission in 1876. Professor Lewes's theory was, to some extent, contrary to the opinion of some very able men who sat on that Commission, notably Sir Frederick Abel and Dr. Percy, which had been generally followed by courts of inquiry since. In one case, an inspector or manager of mines expressed the opinion that, unless there were pyrites in the coal, it would not fire; and the general opinion of the Courts, since 1876, had been that it was generally pyrites which caused spontaneous combustion. Professor Lewes challenged this entirely, and had given some statistics bearing out his view, but his information went no further than 1883; if he had taken the last three years for which the Board of Trade had made returns, he would have have found that they gave an average of something like 25 coal-laden ships per annum which were either known to have been abandoned or were missing, and 200 lives lost. This was a very serious matter, and, if Mr. Lewes were right, the existing precautions were altogether insufficient and illusory, though they were founded on the report of the Royal Commission. That Commission called special attention to a paper by Sir Frederick Abel and Dr. Percy, explaining scientifically the cause of spontaneous com-

bustion, in which a great deal of space was devoted to the part taken by pyrites, though later on they also explained that coal itself was liable to oxidation, and, after explaining the process, they expressly said that this oxidation of the coal was one of the causes, if not the chief cause, of spontaneous combustion. It was strange therefore that, during all these years, not one word had been said, in the course of the many inquiries which had been held, and in which the courts have often been in doubt, to suggest that this was the probable explanation of the ignition of the cargo. On the contrary, attention seemed to have been confined solely to discovering whether the coal in question had pyrites in it, and whether it had been sufficiently screened. Since 1876 there had been altogether 34 inquiries in which the Courts found that the cargoes had fired from spontaneous combustion; but, to make a fair comparison, he had selected those in which the ships were bound to South America, or round Cape Horn. Of these there were 23, of which in nine cases only did the Courts find that pyrites was positively present in any quantity; in 14 it was either absent or present in such infinitesimal quantity that they were unable to assign any cause for the fire. Then, too, the average time from leaving port in which the vessels fired was, where pyrites were present, 2 months, 23 days, when absent, 2 months and 20 days, and this was very important evidence, as showing how little pyrites really had to do with firing these cargoes. He had tabulated these cases, classifying the information obtained as to the class of coal, whether wet or dry, the time the vessel sailed, ventilation, and so on, with a view to getting some explanation of the reason why some cargoes fired in, say two months, while other ships—sailing, apparently, under similar conditions, as regards the coal on board—had taken three months, or even longer, to fire; and it would be found that the conditions of heat and ventilation were important, and had very much to do with this. Vessels which went through the tropics, during the sun's northward course, would travel through the tropics at a time when they would have the longest period of extreme heat on the voyage; but if the sun were on its southern course, the vessel would have the extreme heat for a shorter time. With regard to ventilation, the Courts seem to have had some difficulty in deciding whether iron masts, perforated below the decks, were injurious or not. Through ventilation was now always condemned, especially when lattices were used; but platforms and trunkways had also been deemed dangerous. The most important point perhaps was the management of the hatches, and on that he had collected the following information:—Particulars are not always given in the reports as to the keeping on or taking off the hatches; but where such information is given, there is abundant evidence to show that taking them off to cool the cargo, when it has given evidence of heating, or to dig down and get at the seat of the fire, or to see how the fire is progressing, accelerates combustion in a most alarming way. For instance, the temperature of the *Nagpore's* hold was found to be getting very high—it showed 95° by the thermometer—and next day it was 110°. At this time, the fore and main hatches were off, and by next morning the temperature rose to 120°. Still keeping off the hatches, the thermometer next day registered 130°, and then fire broke out. In the case of the *Mountaineer*, upon smoke appearing, the hatches were taken off, but after trimming the cargo, they were replaced and battened down for the night. Next day they were taken off, to see how matters were progressing, but the smoke was so intense, that the master closed up the hold at once; and after sundry minor explosions next day, the ship finally blew up. This coal had little or no pyrites in it, and had not been much broken, nor was it wet when put on board. Here is another case, in which the coal was clean and dry, but a good deal broken, the *Gad's Hill*. When 96 days' out, smoke was noticed coming from the forehold. Digging down to the seat of the fire, and douching the coals vigorously, they, in four days, believed that they had effectually flooded out the fire. Four days afterwards, however, smoke appeared from the after hold. Attempts to get at the seat of the fire proved a failure, for a foot below the surface the diggers were met by so much steam and smoke, that they were obliged to desist. The hatches were then put on, in hopes of smothering the fire, but this failing, they were again thrown open, to allow the heavy seas, which were breaking over the ship, to fall into the holds; but the fire increased so rapidly, that, on the following day, the crew had to abandon the ship. In this case, the usually supposed causes of spontaneous combustion were not present; and the combustion must have been developing a long time before the first appearance of smoke. How far, previous to the smoke, the opening of the hatches may have contributed to the combustion, we cannot say; but the consequences of keeping off the hatches while digging, and uncovering them, to allow the seas to wash in, are conspicuous in the rapidity with which the fire spread. Here, again is an instance of combustion which probably had been in a state of quiesence for want of air, and was brought into vigorous operation through opening the hatches. The *Yuca* had a cargo which the Court found had pyrites in it, but it had been put on board dry, and not much broken. The vessel was 98 days out on her voyage, and it was necessary to trim the cargo, which had shifted. On opening the hold they found "no signs of heat or gas from the coal;" but, next day, two of the crew were nearly suffocated by gas, and, on examination, the hold was found to be full of it; but still there were no signs of fire. By way of precaution, the hatches were battened down; but, having to get out the cable, they were again opened about twelve hours afterwards, and, as the smoke was very great, they were soon put on, and battened down again. In the course of the next 24

hours, the ship fortunately came in sight of land; but, meanwhile, her main hatch had been blown off, and the flames were coming out of her on both sides, fore and aft, whereupon the crew abandoned her. This is not the only case in which the crew have been deluded into the supposition that all was going well by finding only normal temperature at the surface of the cargo. From similar experience in the *Slieve More*, and other cases, one might assume that combustion had been in active operation, but had lain dormant for some time for want of air, so that there would not be that intense heat at the bottom of the hold which would affect the temperature on the surface of the coal. Anyway, in the *Yuca* case, the course of events positively shows how active is the assistance which the open hatches contribute in developing spontaneous combustion, when there is a tendency to it in the coal at the bottom of a ship's hold. Next comes a case where the hatches had practically always been off. The *Carr Rock* had a cargo in which there was little or no pyrites; it was not more than usually broken, and was put on board dry. At starting, the thermometer indicated 75° Fahr. in her hold; a month afterwards it was 98°, and in another month 120°, whereupon they dug down into the coal; and as at a depth of four feet it was palpable that there was fire all over the hold, they stopped work and clapped on the hatches. Next day the hatches were taken off to see how matters were progressing, but finding the fire was burning furiously, they were soon replaced. Water was poured into the hold; in a few hours explosions occurred, and soon afterwards the crew were obliged to abandon the ship. Here, too, we have none of the usually supposed causes of spontaneous combustion — no pyrites, no wet, no coal in a very broken condition—but we have the fact that the hatches were constantly open, and the coal would probably have been put on board fresh from the pit in a very absorptive condition. We have, therefore, an instance which actually bears out Professor Lewes's contention. From these illustrations, then, may we not assume, as a general principle, that the coal goes through a very simple process? It comes into the ship green, and that part of it which has been most broken, and lies at the bottom of the hold, immediately beneath the hatches, slowly heats. The air which surrounds it becomes warm, and ascends, while the cool air from above rushes in to take its place, and so supplies the oxygen required to assist in the process of combustion; meanwhile, perhaps, the hatches are off, but wet or rough weather sets in, and the hatches are battened down. The hold is then warmer, and combustion is accelerated so long as there is air within reach; and when that air is exhausted, combustion is at a standstill, and would actually remain quiescent so long as no air can get to it; but, with the return of fine weather, the hatches are removed, the hot air then rushes up from below, a new supply of oxygen is drawn down to the now almost burning coal, and, in a few hours, the cargo is alight fore and aft. If this is a correct theory, Professor Lewes is perfectly right as regards keeping the hatches always closed. But now, as regards the sufficiency of the present precautions—assuming that oxidation of the coal and not pyrites is the cause of spontaneous combustion—the existing regulations are incomplete. It is simply required that the coal should not be broken more than could be helped, that pyretic coal should not be put on board wet, and that ventilation through the cargo should be stopped. But what about green coal which is freshly won from the pit, and in its most absorptive condition? What about the facilities on board, through the hatches, for its getting air to sustain and accelerate combustion. It seemed to him that the alarm thermometers suggested by Professor Lewes might be dispensed with, even with advantage, because what was wanted was not the exact spot in which the coal was on fire, but the fact of fire existing anywhere, and that would probably be given by the exit pipe for the gas surface. That gas was inodorous, but when the cargo was burning there must be smoke, which could be seen, and then the only thing was to make for the nearest port. The carbonic acid seemed promising, but it had been tried and failed under some conditions. In one of the colonies, some years ago, a ship was specially fitted up for the special purpose of applying it when vessels on fire came into port, but on one occasion it was poured into the hold of a vessel for several hours without success. Last year a number of people were invited to see some experiments at Liverpool, and a large bonfire in a ship's hold was speedily extinguished, but that could hardly be considered an analogous case. Still, he thought Mr. Lewes had made out a good case for the use of carbonic acid, and certainly he had contributed much information by his most interesting and valuable paper.

Mr. I. G. LORRAIN said he did a good deal of work on this subject some seven or eight years ago, and it was then urged upon him that an alarm was not what was wanted. A captain told him that he did not want to know that the cargo was on fire, he wanted to know what condition the hold was in before it got to that, so that he might take precautions. Charpontier's arrangement, which was somewhat similar to that now suggested, was met with the same objection. The carbonic anhydride arrangement was not new to the Society, as he had made a similar suggestion in 1885, laying stress on its cooling action, as well as on its being a non-supporter of combustion, and in November, 1885, Prof. Silvanus Thompson showed a diagram of the apparatus. With regard to putting a fuse in the mouth of the bottle, it was not always possible to have the bottle in the place where the fire broke out, but he had found a good arrangement was to add some insulating material near the mouth, and mount the fuse in such a way that it acted like a fuse in an electric circuit; then by putting a thermostat in

places where the fire was likely to occur, and having a source of energy sufficient to supply an excess of current that might be relied upon to melt the fuse.

Capt. ANDREW CUNNINGHAM thought when Professor Lewes' views were subjected to a little wholesome criticism by practical men, they might lead to useful results. He had had considerable experience with coal cargoes; and, having come to grief with the first one, he learned so many useful lessons, that he never had another accident. His conclusions were somewhat at variance with those now put forward. He could not go into the chemical part of the question, but, it seemed to him, that moisture was the principal element in determining the combustibility of a cargo. It seemed a truism to talk of the oxidation of pyrites being the cause of ignition. It was like saying that a man died from want of breath. His experience, on his first voyage, was much what Mr. Thomson had indicated, except that he omitted what every master was told by the shipper, that a cargo of that particular coal had never been known to take fire. He sailed from Dundee for San Francisco, and, wishing to be as careful as possible, he kept the hatches up, and had a trunk along the keelson, and an upright shaft too. After a time, when the weather got rougher, he put the hatches on, and was not in a great hurry to get them off; but, 86 days' out, he was told by the second officer that smoke was coming out of the fore hatch. He then took all the hatches off, and began pouring water down, and, after a time, the amoke disappeared. They continued pouring in water during the night, but the following day it became serious, and they began throwing coal overboard, until they got to the lower deck beams; then the coal began to get red-hot under the men's feet, and they had to stop. Then he turned the hose from a donkey-pump into the main hatch, filled the cavity with water, and put on the hatches and battened them down. About midnight there was an explosion, and the next morning he was told that the men were coming aft to ask him to abandon the ship. However, he took off the main-hatch, and found it as cool as an ice-house, the beams and timbers being all covered with coal tar, and he never had any more trouble for the rest of the voyage. The lesson he learned was, as soon as possible after leaving home to insert iron rods down the main and after hatches, by means of which he could tell by the hand how the temperature was getting on. Perpendicular shafts were quite unreliable as a test of temperature; he had seen a thermometer in one of them give a lower temperature than there was on deck, and at the same time he could hardly bear his hand on an iron rod not more than five feet off. He always dug out the main hatch down to the lower deck beams, so as to be all ready for putting water in. He thought the iron rods which he used as indicators might also be of use in conducting away the heat, and allowing it to escape into the air. He had never had any trouble since, though he had been more than once becalmed in the tropics. It was most dangerous to batten down the hatches, considering the large quantity of gas evolved. Professor Lewes had little notion of what shipowners were, or he would not recommend double bulkheads. The great point, in his opinion, was surface ventilation; the hatches should always be kept open, and a ship properly loaded would never take in any water which would injure her. The thermostat might be a nice thing for a laboratory, but would not do for a sailor. He gathered that the *Carr Rock* was filled block up between the beams, and there could not be surface ventilation unless there were several feet to spare between the decks.

Sir JAMES DOUGLASS could not understand how Captain Cunningham could place so much faith in surface ventilation, seeing it was not at all uncommon in the North of England to see a heap of coal on fire in the open air.

The CHAIRMAN said Professor Lewes, in the paper he read at Cardiff, and again in the one he had just read, had taken the first step necessary in devising preventive measures, viz., to point out the causes of the evil to be guarded against. He had disproved the pyrites theory, because, though he did not say it had no effect whatever, he had shown that with coal absolutely free from pyrites, there was sufficient heat generated by the absorption of oxygen to cause spontaneous ignition, unless means were taken to prevent it under the conditions stated. One striking point was the increase of danger as the size of the cargo increased, especially in tropical climates. Two things recommended, he thought, would be found practically impossible. Double bulkheads would be very costly to make and keep watertight, and would take up a great deal of space. It was admitted that no one would use them except under the pressure of legislation; but they could not legislate for foreign countries; and, if too heavy burdens were imposed on English shipping, other people, not subject to the same restrictions, would come and take our trade away. Another suggestion was that coal should not be shipped until it had been a month out of the pit, but that might involve so much expense in removing from one place to another, or from one railway waggon to another, that it would be prohibitive. Coal owners' profits were measured by pence rather than by shillings per ton, and would not bear much diminution in this way. The proposal for the introduction of thermostats into the bulk to show what was going on, reminded him of a difficulty which the late Sir William Siemens experienced from the deterioration of certain cables stored on board a vessel, when he discovered by means of electrical thermometers that there was a spontaneous rise of temperature in them. As a result of those experiments jets of water were flowed over the cables, and, finally, it became the practice to coil the cable in a tank which could be filled with water. He did not see why the use of liquid carbonic acid should not

be available. Many voyages would take place without any liberation of the carbonic acid, and even where it was liberated the cost would not be prohibitive. It was clear that if the temperature could be kept down ignition would not take place, and now-a-days it was becoming very common for large steamers to carry refrigerating apparatus. Where that was the case, he did not see any difficulty in putting pipes near the bottom of the hold, through which a liquid, cooled down by the refrigerating apparatus, could be circulated, and in that way the heat could be abstracted from the bulk of the coal as fast as it was generated. He concluded by proposing a vote of thanks to Professor Lewes for his valuable paper.

The vote of thanks having been carried unanimously,

Mr. LEWES, in reply, said Sir James Douglass had answered Captain Cunningham—with whose views he did not at all agree—on the point of surface ventilation. Captain Cunningham had practical experience, and he had none, but he would rather go in a ship battened down, and with a two-inch pipe to allow the escape of gas, than with any amount of surface ventilation. If cold air were continually supplied to the surface of the coal, it would soak down and take the place of the warmer air, which had parted with its oxygen, and thus you provided the very conditions most favourable for setting up spontaneous combustion. Mr. Cobb had referred to the inconvenience of having to provide a cylinder for every eight tons of cargo, which he admitted, but it would be a great safeguard. It might, however, be arranged in another way. A large central cylinder, holding 1,000 feet, might be employed, and from that might run pipes along near the bottom into the cargo, pierced at intervals with holes closed with fusible plugs; they would melt at any point where heating took place, and allow the escape of carbonic acid. He was much obliged to Mr. Thompson for the valuable information he had given, and only differed from him when he said that the views he had put forward were at variance with those enunciated by Sir Frederick Abel and Dr. Percy. The report referred to, distinctly pointed to the oxidation of the coal as having more to do with the matter than the pyrites; indeed, he quoted the table he had given of the effects of moisture and pyrites from Dr. Percy's work on "Fuel." He should not have referred to the thermostats but for their being so universally used, and did not think there would be any difficulty with them. They should be so arranged as to give warning, not after firing had taken place, but before, so that precautions might be taken. The Chairman objected to double bulkheads, but that was a favourite idea of his; and they were absolutely necessary, if carbonic acid gas was to be used, as there must be a gas tight bulkhead between the cargo and engine-room. If the coal were battened down, which was most important, there must be no leakage of the gas into the engine-room; and the only way he knew of making a bulkhead gas-tight was, by having it double, with water between. The use of refrigerating machinery would be very effective, if the expense were not too great.

Miscellaneous.

RUSSIA AT THE CHICAGO EXHIBITION.

In a Reuter's telegram to the *Morning Post* of the 24th February, it is stated that the preparations for the participation of Russia in the Chicago International Exhibition are proceeding with every promise of the best results. The entire Russian exhibit will be directly under the supervision of the Commission appointed by the Russian Government, which has undertaken to see that the various arts and industries of the Empire shall be worthily represented. The Government has not only accepted the invitation to take part in the Exhibition, but has taken full charge of the work of organising and arranging the exhibits, and besides providing for the Government display, it invites and assures the co-operation of private exhibitors in the several fields of enterprise.

Mr. Emery Smith, United States Minister, and Consul-General Crawford, who has been appointed Commissioner of the Exhibition for Russia, have had a long interview with the President of the Russian Commission. During this conference it was intimated that the Russian Government had resolved to transport at its own expense all articles of the Russian exhibit, public and private, from St. Petersburg to Chicago, and to bring them back from the United States. Russian exhibitors have only to bring to St. Petersburg what they wish to exhibit, and the Government will assume all the rest of the cost and responsibility.

Great care will be exercised to secure a full and varied display, including carpets and other characteristic products of Central Asia. The Imperial porcelain manufactory is already at work on special designs for the Exhibition.

There is reason also to expect that the women's department will receive a handsome contribution from Russia. Minister Smith has presented to the Minister of Foreign Affairs a letter forwarded by the State Department from Mrs. Potter Palmer to the Empress of Russia, inviting the patronage and co-operation of her Majesty in the appointment of a commission of Russian ladies to direct this work. In presenting the letter, Minister Smith explained that the State Department approved the proposal, and was much interested in it, and there is little doubt that it will be accepted.

Correspondence.

BURNING OILS FOR LIGHTHOUSES AND LIGHTSHIPS.

In Mr. Boverton Redwood's letter in your issue of 26th ult., in reply to mine of 19th ult., he is good enough to say that I am entitled to be heard on behalf of the Scottish mineral oil industry; that is a claim, however, which I neither made nor make for myself.

In his reply he overlooks the only two salient points in my letter. First, in reference to the attitude of the Scotch oil companies, I must remind him that it was the Bill of 1891, and the Conferences of 1891, that were alone mentioned or referred to by Mr. Edwards, and by himself, and by me. That issue he avoids, and passes instead to the consideration of circumstances connected with Conferences of four years ago.

Secondly, I did not address myself to the general question of "test standard," as he says. What I did address myself to was Mr. Redwood's specific statement, which I was careful to repeat, viz., "That the results of experiments made by Sir Frederick Abel and himself were, that substantially it was found that a lamp might be said to be in the safest condition when the space above the oil in the reservoir was filled with vapour." My subsequent references to low test and high test oils were simply incidental to the consideration of that remarkable statement.

The question of heat development in lamps is a very important one, but so many and so varied are the producing causes, apart from the oil itself, that space will not admit of its discussion here. The simple element, *per se*, of high test or low test in an oil, counts for very little as a factor in the generation of heat. It is true that some descriptions of high test oils may develop considerable heat, but it is still more true that more heat is more frequently produced by low test oils; but under all ordinary conditions, in ordinary domestic lamps, the temperature of the oil seldom, if ever, rises to 100° Fahr.

Mr. Redwood instances two cases of lamp accidents, where it is said that high-test oils were used, one of them so long ago as 1875. Surely such isolated instances may be held to be exceptions, proving the rule in favour of high-test oils. But no reliable conclusion unfavourable to high-test oils can be drawn from either this one or the other. On turning to Sir Frederick Abel's account of the accident in the training ship *Goliath*, in 1875, we find that the evidence, for the most part, is of a negative character. The lamp had been burning all night; the boy who removed it was new to the work; the heat of the lamp was not so great as to prevent his carrying it from its position in the ship to the lamp or trimming-room before he let it drop, and the floor of this lamp-room was much impregnated with oil carelessly dropped from time to time by lads employed upon the work of lamp trimming; and Sir Frederick Abel adds, "there can be little doubt that this catastrophe has to be classed among the numerous accidents of a readily avertible kind."

In the other case instanced by Mr. Redwood, the lamp was one of the most dangerous that could be nsed, and the accident was admittedly due to the upsetting of the lamp, the burner being at the same time jerked from its position in the reservoir, allowed the oil to flow out freely over the books and papers on the floor, and naturally set fire to by the burning wick.

The doubt suggested in the quotation from Mr. Marvin's letter, regarding the allegation of the Secretary of the Scottish Mineral Oil Association in 1886, that no accidents had occurred with Scotch paraffin for 37 years, can have no influence, unsupported as it is by a particle of evidence. But practical immunity from accidents in the use of Scottish mineral oils, in consequence of the high standard of safety maintained, has been openly and constantly claimed by the oil manufacturers of Scotland during the last 40 years, and, so far as I am aware, that claim has never been challenged or its truth disproved.

Mr. Redwood refers to another point not mentioned or discussed in my letter, viz., the present legal standard. He is quite entitled to maintain that that standard is not too low; but it is one thing to do that, and quite another thing to endeavour, at the same time, to discredit high test oils in the estimation of the public.

Mr. Redwood refers to certain circumstances under which the use of oils of higher flashing-point might be advocated. It would be interesting to know which these circumstances are.

WILLIAM LOVE.

General Notes.

PATENTS AT THE CHICAGO EXHIBITION.—The United States Senate has passed a special bill enacting that no foreign citizen shall be held liable for infringing any patent trade mark or label registered in the United States if the act is performed in connection with the exposition of any article or thing at the Chicago World's Fair.

DEDICATION OF EXHIBITION BUILDINGS.—The Exposition buildings, as required by Act of Congress, will be dedicated, "with appropriate ceremonies," on October 12, 1892, the 400th anniversary of the discovery of America by Columbus. The exercises will occupy three days, beginning on the 11th and closing on the 13th with a graud ball. The Committee having the matter in charge intend to make the

ceremonies most impressive in character. The President of the United States and his Cabinet, the Senate and House of Representatives, the Governors of the several States, with their staffs, and representatives of all foreign nations will be invited to be present. The mobilisation of 10,000 militia and several thousand regulars is planned, as is also an imposing civic and industrial display. In the evenings there will be a display of fireworks, and in the park waterways a pageant of symbolical vessels, representing the "Procession of the Centuries." In the dedicatory exercises on the 12th, the completed buildings will be tendered by the President of the Exposition to the National Commission. President T. W. Palmer will accept them on behalf of that body, and will at once present them to the President of the United States, who will fittingly respond. The dedicatory oration will follow. Much attention is being given to the musical portion of the programme. In April, 1893, a grand international naval review, preliminary to the opening of the Exposition, as provided for by Act of Congress, will be held in New York harbour. Arrangements for this are now being made.

FIBRE INDUSTRY IN QUEENSLAND.—A new industry is about to be started in the Wide Bay district, Queensland. The *Melbourne Age* learns that a syndicate of nine Maryborough districts are about to lease 100 acres of land in Tinana for the purpose of growing aloe, from which sisal hemp is manufactured. They have already put in the ground over 1,000 plants, and expect to realise at least £21 per ton for the fibre when grown. This is even better than sugar cane, and can be grown with very much less trouble and a very inferior land. Walkers, Limited, are making arrangements for the manufacture of machinery for cleaning the fibre. A large quantity of twine, used chiefly for binding purposes, is imported into Australia from the United States, made from sisal hemp, which is found to be most suitable for the purpose.—*Board of Trade Journal.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 9.—A. P. LAURIE, M.A., "Experiments on the Durability of Modern Pigments."

MARCH 16.—TEMPEST ANDERSON, M.D., "Iceland."

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing."

MARCH 30.—EWING MATHESON, "Foreign Exchange."

Papers, the dates of reading of which are not yet fixed:—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

"Egyptian Agriculture." By Professor ROBERT WALLACE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

MARCH 15.—F. A. PEZET (Peruvian Consul General), "Peru: its Commerce and Resources." CLEMENTS R. MARKHAM, C.B., F.R.S., will preside. 8 p.m.

APRIL 5.—The Rev. JOHN MCLEAN, D.D. "Manitoba and the North-West Provinces of the Dominion."

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "The Progress of Australasia."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. WILLIAM ROBINSON, M.E., Assoc. M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

LECTURE II.—MARCH 7.—*Petroleum Oil-engines.* —Heating of oils—Mixing and firing of charge in the internal combustion engine—Use of regenerator —Modes of governing—Practical tests—Study of indicator diagrams—Efficiency—Present economy and future possibilities.

LECTURE III.—MARCH 14.—*Oil Gas.*—Gas generator and internal combustion engine *versus* steam-boiler and steam-engine.

LECTURE IV.—MARCH 21.—*Oil Fuel and Gaseous Fuel for Steam-boilers.*—Safe heavy oils available—Different methods of burning oils—Injector-burners —Evaporative power of oil fuel.—Advantages and disadvantages of liquid fuel on steamships—Transport and storage of petroleum—Other uses of petroleum for power purposes.

BENNETT H. BROUGH, "Mine Surveying." Three Lectures.
March 28, April, 4, 11.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bateriology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. William Robinson, "The Uses of Petroleum in Prime Movers." (Lecture II.)

Royal Institution, Albemarle-street, W.. 5 p.m. General Monthly Meeting.

Engineers, Westminster Town Hall, 7½ p.m. Mr. Stephen Sellon, "Electrical Traction and its Financial Aspect."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Oscar Guttman, "The Dangers attending the Manufacture of Explosives." 2. Drs. Evans and Wirtz, and Messrs. Cross and Bevan, "The Acid Action of Drawing Papers."

British Architects, 9, Conduit-street, W., 8 p.m. Paper on "Suggestions for the Conduct of Architectural Competition."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Sir Joseph Fayrer, "Serpent Worship and the Venomous Snakes of India."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Blackburn, "The Portrait Painters." (Illustrated.)

TUESDAY, MARCH 8...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture VIII.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Professor W. Cawthorne Unwin, "Petroleum Engines."

Photographic, Great Russell-street, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Allen Brown, "On the Continuity of the Palæolithic and Neolithic Periods. 2. Rev. James Macdonald, "East Central African Customs."

Colonial Institute, Whitehall Rooms, Hotel Métropole, Whitehall-place, S.W., 8 p.m. Mr. John Ferguson, "Ceylon: its Attractions to Visitors and Settlers."

WEDNESDAY, MARCH 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. P. Laurie, "Experiments on the Durability of Modern Pigments."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. Louis Parkes, "The Air and Water of London: Are they Deteriorating?"

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m. Annual Meeting.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. T. E. Freshwater, "The Oxyhydrogen Microscope."

East India Association, Westminster Town-hall, S.W., 2½ p m. Mr. J. F. Darling, "Recent Silver Legislation and its Effect on India."

THURSDAY, MARCH 10...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. W. Rudler, "The Diamond."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. P. Ker, "The Progress of Romance in the Middle Ages. (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 11 ... United Service Inst., Whitehall-yard, 3 p.m. Mr. W. B. Tegetmeier, "Pigeons for Land and Sea Service, with examples from recent experiments."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting 9 p.m. Mr. F. T. Piggott, "Japanesque."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting). Mr. James B. Ball, "The Manufacture of Oil-Gas at the Holloway Works of the Great Northern Railway Company."

Astronomical, Burlington-house, W., 8 p.m.

Junior Engineering Society, Westminster-palace-hotel, Victoria-street, S.W., 8 p.m. Mr. Frank W. Page, "The Principles and Action of a direct-acting Pump."

Clinical, 20, Hanover-square, W., 8½ p.m.

Institute of Architecture, Dundee. Mr. T. Claxton Fidler, "The Evidence of Scientific Knowledge in the Remains of Ancient Architecture and Engineering."

Physical, Science Schools, South Kensington, S.W., 5 p.m. Mr. H. M. Elder, "Thermodynamics, and the Action of Light on Silver." 2. Prof. J. Perry, "On Choking Coils."

SATURDAY, MARCH 12...Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Mr. C. V. Boys, "Electric Spark Photography."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture V.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, MARCH 11, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. WILLIAM ROBINSON, M.E., Assoc. M.Inst.C.E., delivered the second lecture of his course on "The Uses of Petroleum in Prime Movers," on Monday evening, 7th inst.

The lectures will be printed in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1892 early in May next. The medal has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in ecognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

The Council invite Members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour.

Chicago Exhibition, 1893.

MEETING IN DUBLIN.

A meeting was held in the City-hall, Dublin, on Friday, 4th inst., for the purpose of taking steps for the proper representation of Irish manufactures at the Exhibition, the Lord Mayor being in the chair.

The LORD MAYOR said the object of the meeting was to take steps to secure that Ireland should be represented at the forthcoming Exhibition at Chicago. The matter had engaged the attention of several of their public bodies, amongst others the Corporation of Dublin, which had appointed a committee, the Chamber of Commerce, which had appointed another committee, and the Royal Dublin Society which had also appointed a committee. The members of these committees had several meetings, with the result that they had invited Sir Henry Wood, Secretary of the Royal Commission, to attend on that occasion, and give them some information.

Sir HENRY TRUEMAN WOOD said he wished first to assure the meeting that the British Royal Commission were most anxious to do everything in their power to facilitate the representation of Irish industries on this occasion. He desired at once to clear away a misapprehension which might exist in some quarters—namely, that it was too late to take action in this matter. That was not at all the case. The end of last month was no doubt the time fixed for receiving applications, but that was because some time must be fixed, in order that they might get some idea of

what was likely to be sent in, and to enable them to allocate the space to those who required it. In Ireland and England a sufficient number of applications had come to make it quite certain that there would be a satisfactory representation of both countries. But the whole space was by no means occupied. There was still ample room for those who wished to come in. He did not wish them to think that there should be any unreasonable delay, but he did wish them to understand that there was plenty of time, and that if the Irish manufacturers applied without undue delay there was no reason why their requirements should not be fulfilled. America to a large extent was populated from Ireland, and America's greatest strength came from Ireland. It is natural that the chief city in the west of the States of America would be anxious to see Ireland take part in their great Exhibition. The appeal came with great force to Ireland, which sent so many thousands every year to the New World. Chicago was surrounded by an immense Irish population, and anything coming from the old country would be received with an enthusiastic welcome by them. It was feared that the expense of transit of goods 3,000 miles by sea and 1,000 miles by rail would deter many from sending exhibits, but he might say that both in England and America reductions would be made in the freights. It was then feared that the M'Kinley tariff would be a great objection. No doubt there had been some reductions in the imports into America since the tariff came into operation, but one the greatest trades in this country—the linen trade—had not suffered. Linen—at least good linen—could not be made in America, and if the Americans wanted it they must get it from this country, and if the tariff had increased for imports there, they must pay an increased price for the goods. The trade would go on, very slightly diminished for a time in spite of whatever tariff there might be. He was glad to say that the linen trade of Ireland would be well represented at the forthcoming Exhibition. Some of the foremost houses in the trade had made application for space in which to exhibit their goods. He hoped that the woollen manufactures of Ireland would be well represented. The Home Industries Association, of which Lady Aberdeen was president, had taken important action—and he hoped that in England the example would be followed—with the view of affording small exhibitors an opportunity of showing their goods—the makers of lace, and a thousand small items like that. They could not expect exhibitors of that class to go to the expense of sending their small exhibits; but if the thing was done properly, as it was being done by the Home Industries Association, there was no reason why a considerable impulse should not be given to the home industries of Ireland. He would conclude by expressing a most earnest hope that that meeting would result in a thorough and adequate representation of the more important Irish industries at the most magnificent Exhibition which this generation had seen.

The Right Rev. Monsignor MOLLOY moved:—"That it is important that steps should be taken to secure an adequate representation of Irish art and industries at the Chicago Exhibition."

The resolution was seconded by Alderman Sir HENRY COCHRANE, and adopted.

Mr. J. J. O'MEARA, T.C., moved:—"That a committee be formed for the purpose of co-operating with the Royal Commission for the purpose of securing adequate representation of Irish industries at the Chicago Exhibition." This object would, perhaps, be best accomplished by the amalgamation of the sub-committees already appointed by the Chamber of Commerce, the Royal Dublin Society, and the Corporation.

Mr. JAMES TALBOT POWER seconded the resolution, which was adopted.

Alderman ROBERT SEXTON, J.P., moved that the following gentlemen be asked to act on the committee:—"The Right Hon. the Lord Mayor, Messrs. J. J. O'Meara, T.C., Alderman Sir Henry Cochrane, J.P., James Shanks, John M'Quaid, John Beveridge, the Earl of Rosse, Sir Howard Grubb, Right Rev. Monsignor Molloy, R. J. Moss, James Talbot Power, D.L., Edmond Johnson, Hon. Horace Plunkett, Dr. E. Percival Wright, Peter White, James Brennan, John R. Wigham, J.P., E. J. Figgis, J. Malcolm Inglis, and Sir Thomas Deane, with power to add to their number."

Sir THOMAS DEANE seconded the motion, which was adopted.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Intending exhibitors are reminded that applications for space must be made immediately, as the allotment of space will shortly commence. Most of the available space is now occupied, and no time should therefore be lost by manufacturers desiring to be represented.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

INDIAN SECTION.

Thursday, March 3, 1892; Major-General Sir OWEN TUBOR BURNE, K.C.S.I., C.I.E., in the chair.

The paper read was—

INDIAN SANITATION AND THE INTERNATIONAL CONGRESS OF HYGIENE.

By Surgeon-Gen. Sir William Moore, K.C.I.E., Q.H.P.

When I went to India first, in the year 1852, an acquaintance said to me, "Well, it's a very hot country, but there is one advantage, you will be able to get plenty of East India pale ale there!" evidently supposing that India was where the pale ale came from! Again, when I first went out to India, the junior medical officers were denominated assistant surgeons, a designation which has been for some time since abolished. I went to visit two old ladies. One said, "You are going to be an assistant surgeon, are you not?" to which I replied, "Yes!" "And," asked the other, "has the gentleman you are going to be an assistant to a very large practice?" To which I replied, "Oh, yes! Mr. John Company has a very large practice indeed!"

When I arrived in India, I was ordered to Ahmednuggur, in the Deccan, and it was, at that time, twelve or fifteen days' march—this being before the era of railways. The first stage from Bombay was to a place called Panwell, which was done by water, in what is termed a "bunder boat;" but a horse I had was obliged to go some distance round by land. While waiting at the travellers' bungalow at Panwell, I suppose I was showing anxiety about the non-arrival of the horse, as I wanted to continue my journey. A soldier in the bungalow, who had attained the rank of conductor in some department or other, seeing me fuming, asked the reason. "Well, sir," said he, "never mind; no one is ever in a hurry in this country."

Now, I have introduced these anecdotes because they tend to illustrate, first, the dense ignorance which prevailed in England regarding India two or three decades back; and, secondly, because the last anecdote ilustrates the ideas which prevailed in India at the time; ideas which have radically changed, for nowadays people seem to be in as great a hurry in India as in any other country. Doubtless much ignorance prevails with regard to India even now, an ignorance which has probably been intensified, rather than the reverse, by various books which have been published on the strength of a winter tour. In a healthy state of society, an Act of Parliament would be passed, that no one should write a book about India unless he or she had dwelt two hot seasons on the plains, learnt the language, and travelled through the country, far from railways, for at least 1,000 miles, as a "chota sahib," with a small hill tent, a tatoo, say two servants, and a gun.

The introduction of an Indian Section at the recent International Congress of Hygiene has shown two things. Firstly, that a large amount of interest is now taken in Indian affairs, demonstrated by the fact that four Indian delegates and Mr. S. Digby, the honorary secretary of the Indian Section, were invited to visit the Queen-Empress; also demonstrated by the number of persons attending the Indian Section, by the animated debates, by the somewhat full reports in the Press of the Indian meetings, and by the fact that Reuter sent telegrams from Mr. S. Digby to India free, in connection with the Congress. Secondly, that the Indian Government, the Indian Press, and the Indian people took great interest in the matter, demonstrated by the appointment by the Government of India and the local Governments, by the universities and colleges of India, by the leading municipalities, by the Chambers of Commerce and trade associations, by native and other societies, of some seventy delegates; also demonstrated by the numerous comments in the Indian native Press, the *Reis Ryatt* terming the International Congress "The Durbar of all nations in life science;" also demonstrated by the number of papers sent in by Indian gentlemen. Further demonstrated by the number of subscriptions received from India. Non-official India has never before participated on the same scale in an International Congress.

Among the subscribers to the Congress in India were H.H. the Maharajah of Vizianagram, £200; H.H. the Maharajah of Bhavnagar, £200; H.H. the Gaekwar of Baroda, £100; H.H. the Nizam, £100; H.H. the Maharajah of Jeypoor, £100; H.H. the Maharajah of Mysore, £100; H.H. the Maharajah of Travancore, £100; H.H. the Maharajah of Kooch Behar, £50; H.H. the Nawab of Junagurh, £18; H.H. the Rao of Kutch, £18; Rao Bahadur Runcholal Chotallel, £10; Sir Dinshaw Manocjee Petit, £10; The Maharajah Bahadur Tippera, £10. The total ssbscriptions from India, and gentlemen connected with India, amounted to upwards of £1,070.

Among the papers submitted on Indian subjects were my own, on "Sanitary Progress in India;" "The Progress of Sanitation and

Preventive Medicine in Rajpootana," by Surgeon Lieut.-Colonel Hendley, C.I.E.; "Sanitary Wants in the Bombay Presidency," by Surgeon-Major Kirtikar; "The Sanitary Condition of the Towns and Villages of the Bombay Presidency," by Dr. K. V. Dhurandur, Medical Officer and Superintendent of Vaccination at Baroda, in H.H. the Guicowar's territory; "A Note on the Hygiene and Demographic Condition of India," by Vishram Ramji Ghole, Gra. Grant Med. Coll., and Honorary Assist.-Surgeon to the Viceroy; "Village Sanitation," by Mr. Lionel Ashburne, C.S.I.; "Indian Factory Legislation," by Dr. Bahadhurji.

Now, considering all the circumstances, I think that the foregoing shows a good record. It must be recollected that the Indian Committee was an afterthought; and it had less than six months in which to interest the great Empire of India in the Congress. When the committee was formed in February of last year, and Mr. S. Digby was appointed honorary secretary, not a single delegate had been nominated or a single rupee subscribed. The work was rendered more difficult, owing to everything having to be initiated on this side; whereas, in France, Germany, Italy, &c., there were national committees who made arrangements. We had no committee in India, and there was not time to take the necessary steps to form one. Whatever success the Indian Section may have attained is mainly due to the indefatigable exertions of the honorary secretary, Mr. S. Digby, who spared neither time nor labour in the work, and there was great expenditure of both. This was recognised by the Press. In the *Times* of August 12th it is observed, "To Mr. S. Digby is wholly due the credit of organising the Indian committee, and of interesting Indian princes and others in the success of the Congress."

I propose now to briefly review the work of the Indian Section at the Congress. It was opened by the Right Hon. Sir Mountstuart Grant Duff as chairman. The first paper read was one by myself, entitled "Sanitary Progress in India." In this paper I traced the origin and advance of the sanitary department to the present time, and showed how the policy had been to connect sanitary improvement with municipal government. Various matters were mentioned which, although not coming directly under the heading sanitary, are nevertheless most important agents in the health of the people, such as improvement of the food supply by improved agriculture, and especially by irrigation, in connection with which subject the increase of fever was commented upon; the cheapening of salt; railway communication, by which better distribution of grain and of salt has been secured; the education of the people, which renders them more disposed to look favourably on sanitation; forest conservancy, which, in the future, may be expected to tend to secure a more constant rainfall, and also to prevent water running off immediately without soaking into the ground, and so lessen recurrence of scarcity and famine.*

There are very extensive districts in India which have become semi-desert from the destruction of the forest trees during generations back, principally for the feeding of camels and for fuel. So scarce is fuel in Rajpootana, especially in Marwar, that I have often seen men dismount and gather the camel's "leep" into a bag, carried for the purpose, the contents to be afterwards used for fuel.

Next, subjects more especially sanitary were discussed, viz., conservancy and village conservancy. On this subject I remarked that I was not satisfied with the system of public latrines which has been adopted, and which, for various reasons, as expressed in my paper, I regard as less desirable than the old system of the people, under certain limitations.

Next were considered drainage, local and general; vaccination; ventilation of towns and villages; water supply; the investigation of causes of disease undertaken in India; cholera; quarantine against Indian ports; the pilgrim traffic. The result of sanitary progress was then given; first, in accordance with the opinions of the sanitary officers of India, and, secondly, my own opinions. The conditions of Bombay, Madras, and Calcutta were contrasted with what they were years back. Next, the difficulties of sanitating in India were shown. Then came special remarks on military sanitation.† Lastly, I gave a chrono-

* In connection with this subject, I ventured to observe, that if the anti-opiumists succeeded in their attempts to limit the consumption of opium in India to physicians' prescriptions, thousands more would die from want during seasons of scarcity than now succumb, for opium enables people to exist on less food; and thousands more would die from fever than now do, for opium is to some extent a prophylactic against malarious fevers. I also exposed the fallacy of those anti-opiumists who have stated that famines in India resulted from so much ground being taken up for opium that sufficient did not remain for the cultivation of cereals. The fact being, that only a decimal proportion of the cultivable land in India is devoted to opium.

† Here I observed that the abolition of the Contagious Diseases Act in India was calculated to do more harm to the British soldier in India than all the other sanitary measures could compensate.

logical record of the principal sanitary improvements which had been accomplished in every province in India.

As showing progress in India, I referred especially to hospitals. The institution of hospitals in India must be regarded as one of the beneficial results of British supremacy. In ancient times, excepting during the comparatively short period of Buddhist ascendancy —from 250 B.C. to 500 A.D.—there does not appear to have been anything of the nature of a hospital. We do not find, in the *Shastras*, or *Vedic Hymns*, any reference to public hospitals. Neither were hospitals established during Mahomedan supremacy. At first, British hospitals in India were all military; but, as a measure, both of policy and humanity, medical aid was extended to natives. But, as matters settled down, and civil officials with their establishments appeared, the provision of special medical attendance became a necessity, so civil hospitals were established at all large centres. The success attending this soon led to the provision of branch hospitals and district dispensaries, many of which have been built by the liberality of native gentlemen. As showing the extension of the hospital system in India, I will mention that, in 1858-60, there were not, I believe, more than 181 institutions, treating 111,116 patients. In 1889-90, the number had increased to 1,641 institutions, treating 12,243,000 patients. There were also 25 lunatic asylums and 23 leper asylums. In addition to the above, there were 48 female hospitals or dispensaries in connection with the National Association for Supplying Medical Aid to the Women of India, established by Lady Dufferin.

Surgeon Lieut.-Colonel Hendley, C.I.E., delegate for Rajpootana, followed next with a paper on the "Progress of Sanitation and Preventive Medicine in Rajpootana." With the exception of the comparatively small district of Ajmere (Mhairwarrah), the whole of Rajpootana consists of native States, of which there are twelve. Surgeon - Lieut. - Colonel Hendley first described the ordinary condition of a Rajpootana capital. The poorer classes defile the outskirts of the town; the richer have private conveniences, generally out of repair. There are few drains. The gullies and narrow streets are rarely cleansed. Bullocks and horses are stalled in the house. Milk kine act as scavengers. The soil becomes charged with saline matters, which in time renders the water of the wells undrinkable. This, Surgeon Lieut.-Colonel Hendley states, explains the reason why every great Rajpoot principality has at least one, but often two or even more former capitals now in ruins. In the villages, Dr. Hendley states, every man does what is right in his own eyes, unchecked by the officials, by the nobles, or by public opinion, the result being entire absence of sanitation as described by Dr. Hendley.

Now it is some years since I left Rajpootana, where I was employed for a lengthened period. Even then sanitation in the capitals was dawning; and my impression certainly was, that in the capitals, at least, the condition was much improved in comparison with that described by Surgeon Lieut.-Colonel Hendley. I also remark that I do not agree with Dr. Hendley as regards the cause of the saline condition of the wells. As a rule, throughout western Rajpootana, whether in towns or not, a well of sweet water is exceptional, the ground being impregnated with saline matter. Surgeon Lieut. - Colonel Hendley next described the difficulties attending sanitation. These are chiefly low position of villages, prejudices and conservatism of the people, dirty habits, foul feeding of milk cattle, the comparatively small number of the sweeper caste among the population, &c. I wish I had time to quote Dr. Hendley on these heads, instead of referring you to his most interesting paper.

Although giving so unfavourably a description of the native States capitals, Surgeon Lieut. - Colonel Hendley mentioned much which has been effected. At Jeypoor there is an excellent constant service of water, also public gardens, a railway for the conveyance away of refuse, a conservancy establishment, latrines, main streets swept and watered, numbering of houses, and registration of births and deaths. At Jodhpoor new tanks, from which water is brought into the city, many public latrines, conservancy establishment, and public gardens. Odeypoor, Ulwur, and Kotah, are also mentioned as cities in which sanitation has advanced. Much advance has also been made in the condition of the jails of the native States. Dr. Hendley remarks that, twenty years ago, the prisoners were fastened together at night by a long chain, and men and women frequently lived together both by night and by day. Now, I had a good deal to do with the Rajpootana jails, and I do not recollect seeing the last-mentioned state of affairs, although the sanitary condition of many of the jails was very

inferior. Now, the reverse may be said of the jails of nearly all the native principalities.

I must next refer to a paper by Surgeon-Major Kirtikar, entitled "Sanitary Wants in the Bombay Presidency," which was read by Sir William Wedderburn, Bart., as delegate of the Poona Savajanik Sabha. After discussing the normal condition of an Indian village, and mentioning the sanitary regulations which it has been sought to apply to villages, Dr. Kirtikar says:—"It is the executive we want to carry out these rules. He should be a man from among the villagers, but he must be one who not only himself understands what sanitation means, and how sanitary measures should be brought to the notice of the villagers, and how he should help them and persuade them to carry out those measures, but he should also have an official status which will command respect. He must be a tolerably well-paid minor sanitary officer, just as much as the *patel* and *talati* in financial and revenue matters...... These minor sanitary officers must work direct under a sanitary officer for each collectorate. ..... It may be said that this would mean money. Of course it must cost money to improve the present state of things. Where the money is to come from is a question I need not concern myself with. One of the greatest wants of the country all over is a pure and plentiful supply of water. Every large town should have its waterworks. Where there is want of money, it should be borrowed, and the posterity, which will, in the end, be the greater gainer from such works, should be made to contribute, the town handing down the debt from father to son." Dr. Kirtikar also thinks "the stringent hand of a powerful and well-meaning Government should put down the very dangerous and sinful practice of adulterating our milk-supply with water."

The repeal of the Contagious Disease Act is rightly regarded as a retrograde movement. Vaccination, Dr. Kirtikar thinks, should be made compulsory everywhere. Now, with all deference to the writer, I opine he does not sufficiently consider ways and means; and he would rely more on direct orders from Government than is desirable. And this, although he quotes Surgeon-General Cunningham, C.I.E., who very aptly said: "In all matters connected with sanitary improvement the State may render valuable aid, but more depends on the people themselves." Neither do I think that Dr. Kirtikar has given sufficient credit, especially in the way of water supply, for what has been done. For, while mentioning the works of the former rulers of India in the way of tanks, aqueducts, &c., he does not say anything about the various towns and villages in the Presidency of Bombay which have been provided with good water supply. These are, however, enumerated in my paper.

I next refer to a "Note on the Sanitary Condition of the Towns and Villages of the Bombay Presidency, and the means for improving the same," by Dr. K. V. Dhurandar, Medical Officer and Superintendent of Vaccination at Baroda. The author first considers the situation of Indian towns which were chosen from considerations of defence rather than of sanitation. The roads of towns and villages are not in proportion to the requirements of the place, being narrow and tortuous. The dwellings are not constructed with reference to any sanitary principles. Latrines or trenches are advised for villages, but, where water is available, water carriage. The high price of salt is mentioned as preventing the proper curing of fish, which is therefore often eaten in a state of putrefaction. It is regretted that crematoria are not in use. The practice of the burial of still-born children in the rooms in which they are born has not attracted sufficient attention.

"The poverty of the people makes them impatient to municipal burdens, and no large work of reform can be undertaken without considerable expenditure. Formerly Government advanced loans from public funds or extended its guarantee to municipal loans. Government has shown considerable unwillingness of late years to follow this policy. The municipalities, left to themselves, cannot borrow money on cheap terms. People cannot bear additional taxation, and so, from year to year, large undertakings have to be put off, till the work of reform becomes, if possible, more urgent and more expensive." Lastly Dr. Dhurandar says, "Let the Government for some time more continue to instruct and guide, and refrain from undue interference or official pressure, and let it further liberally help, where help is necessary, and the results will satisfy all who feel an interest in the prosperity of the people of this country."

Now I must say that I more agree with Dr. Dhurander than with Dr. Kirtikar, for sanitation cannot be thrust on the people of India until very much remaining ignorance and apathy have been dispelled.

I next refer to a "Note on the Hygienic and Demographic Condition of India," by Vishram

Ramji Ghole, G.G.M.C. and honorary assistant-surgeon to the Viceroy of India. Dr. Ghole says the water supply, on the whole, is scanty and unwholesome, and that the people are mostly indifferent to its purity. Generally speaking, the people are badly housed, and ventilation is lamentably defective. A most unsanitary, injurious, and filthy practice exists in some parts of the country of having privy-pits, which are seldom, or never cleansed. In the matter of food, the people of India are badly off, owing to general poverty, "and they have usually to pass their days on scanty fare." The people are also scantily clothed. Drainage is referred to as very defective. Burial-grounds in large cities are injurious to the population. The practice of housing cattle, horses, asses in the dwelling-house is condemned. Dr. Ghole says that drinking is on the increase; that the use of Indian hemp, ganga or bhang, is very common; that syphilis is on the increase; that Hindoo bathing is merely nominal; that the sedentary habits of large classes act perniciously; that early and unequal marriages deteriorates race; that enforced widowhood has entailed a fearful amount of misery; that the filthy water used at Jatras and fairs and places of pilgrimage—which the pilgrim delights to bathe in and drink—is the cause of the outbreak of diseases; that caste demoralises the people, and checks the intellectual growth of the population. Lastly, Dr. Ghole says, "The missionaries have done much good in this direction, by diffusing a knowledge of the laws of sanitation. They are teaching the people, wherever they can, the simple rules of health—the necessary conditions of physical well-being."

Mr. Lionel Ashburner, C.S.I., formerly one of the Honourable Members of Council of the Government of Bombay, also contributed a paper on "Village Sanitation," in which he truly pointed out, that the Act of the Bombay Government, passed last year, for providing for the better sanitation of villages would fail to secure the necessary funds for the purpose. Mr. Ashburner rightly considers that the trench system is best for small villages.

Mr. Burjorjee Byramjee, Member of the State Council and head of the Medical Department of Bhavnagur, contributed an interesting note on the topography and sanitation of Bhavnagur, showing that sanitary measures have advanced in this native State. "How can the Masses in India be made to comprehend the Elementary Principles of Sanitary Science?" was the title of a paper by Professor Jamsetjee Unvala, Principal of the Samaldos College of Bhavnagur. The Professor thinks that a knowledge of sanitary science should be made compulsory at the school final examination. Public bodies, he thinks, should be asked by Government to organise systems of lectures on sanitary science, which, on the principle that appeal to the eye has a more lasting effect than appeal to the ear, should be illustrated by the magic-lantern.

"Some Practical Measures needed for the Development of State Hygiene in India" were noted by Dinshaw Ardeshir Sahib of Baroda, among which the appointment of a sanitary Member of Council in India, and the establishment, by Government, of a hygienic journal, are advocated.

An excellent paper on "Sanitation in Ceylon" was forwarded by Dr. Solomon Fernando, which shows that much improvement has taken place in that island.

Other papers, which might have been appropriately read in the Indian Section, were—"The Prevention of Fever in India," by myself, read in the Section of Preventive Medicine; "Sanitation in India," by Mr. Baldwin Latham; "The Water Supply of India," by Brigade-Surgeon Pringle; "Enteric Fever in the European Army of India," by D. Lane Notter, Professor of Military Surgery, Netley; "Hygiene for the Zenanas of India," by Surgeon-General Francis; "The Suitability of Tropical Highlands for European Settlement," by myself. All these were read in different Sections.

An important subject brought before the Congress was the Indian factory legislation question, Mr. Holt-Hallett taking one view, and Dr. Bahadhurji, of Bombay, the opposite. If there were sufficient time to analyse what was said, I think it would appear that Mr. Holt-Hallett overstated the case of the mill hands by selecting chance incidents, and by holding them forth as ordinary occurrences. Whether or not it is correct, as lately stated by Mr. Cotton, of Bombay (*Times of India*, Dec. 19), that Mr. Holt-Hallett had never been in an Indian mill, and knew nothing of the conditions of labour, as conducted in Indian mills I have no means of ascertaining. It is certain, however, that Dr. Bahadhurji knows all about the mills of Bombay; and he expressly states that the mill-hands, as described by Mr. Holt-Hallett, do not exist in Bombay, or in any other part of India. Dr. Bahadhurji

says :—" With these women restricted hours does not mean restricted labour. Abstract principles are applicable to ideal States, but they should be modified to suit actual conditions." The conclusion to be drawn from the papers on "Factory Employment in India" is, that factory legislation should rest with the Indian authorities rather than with the Home Government, or even the Imperial Parliament.

Dr. Bahadhurji has certainly recently scored, for the female mill hands of Ahmedabad have made a direct appeal to him to try and obtain for them exemption from the eleven hour rule, which came into operation on the 1st of January.

I am sorry I cannot review the animated debates which took place on these papers.

Now, I cannot assert that what has been said as regards Indian sanitary defects is, as respects many places, either overdrawn or incorrect. But I differ altogether from some of the conclusions which have been drawn therefrom, and which were aired at the recent Venice Sanitary Conference.

Certain delegates at Venice reiterated as facts what I believe to be fallacies. They still asserted, that as a consequence of defective sanitation, India is the manufactory of cholera, and that cholera is conveyed to Europe, either *viâ* the Suez Canal or by a much more circuitous route overland, through the countries between India and Europe. To support his views, one delegate quoted certain speakers at the International Congress of Hygiene, who expatiated on various Indian deficiencies. The delegate also quoted some official reports to a similar effect. But the great advances which have been made in Indian sanitation were altogether ignored. Yet there are no three large cities in Europe where greater advances in sanitation can be shown than in the cities of Bombay, Madras, and Calcutta during the last two decades. And there are numbers of towns and villages in India, the sanitary condition of which would compare favourably with that of numbers of towns and villages in Great Britain; which would compare still more favourably with a greater number of villages and towns on the continent of Europe; and which would compare most favourably with towns and villages of China, Afghanistan, Persia, Arabia, Turkey, and other Eastern countries.

In Mrs. Bishop's recently published book, "Journeys in Persia," there are various descriptions of unsanitary towns and villages, of which I will quote one. In Kizil-Rohat, "the dirt is appalling, even in this dry weather. In spring the alleys of the town are impassable, and people whose business calls them out, cross from roof to roof on boards. Pools of filthy water, loathsome ditches with broad margins of trodden slime full of abominations, ruins of houses, yards foul with refuse, half-clothed and wholly unwashed children . . . . a well-built brick bazaar, more mud and dirt, some ruinous caravanserais, and near the extremity of the town is the horrible one in which I am now, said to be the best, with a yard a foot deep in manure and slush, in the midst of which is the well, and around which are stables and recesses for travellers."

It would, therefore, appear that if continental authorities require unsanitary conditions in eastern countries, as the breeding ground of cholera, they need not project so far east as Hindustan. They might reasonably attribute cholera to the total absence of sanitation in the countries between Europe and India, where the climate is favourable to the disease, and where doubtless much more cholera occurs than we even hear of. But preaching to the shadowy governments of the countries named the necessity of sanitation, in order to prevent the spread of cholera into Europe, would be too absurd. Whereas the Government of India is a prominent powerful fact, with Europeans at its head, and hence to be impressed by European opinion. Some cynic observed that there is always a satisfaction in discovering a blot on one's neighbour's game. There may therefore be some gratification from attaching to the possession of the great Eastern Empire the odium of sending cholera to Europe as a consequence of the want of sanitary care. In my paper on "The Progress of Sanitation in India," it was shown how, in many different manners, the Government of India had endeavoured to meet the views of previous sanitary conferences; almost the only absolute refusal being, that the Indian Government declined to stop pilgrimage in India, or to harass the pilgrims unnecessarily at the instance of the Congresses.

It is not in the power of the Indian Government to put a stop to the cholera in India. Owing to the climate, food, defective personal hygiene, the demands of creed, in short, to general environment, cholera, in one phase or other, is always present in India. But that this Indian cholera is the source from which European epidemics arise I do not believe. Endeavours have been made to connect more or less vague reports of cholera in Beelochistan,

in Afghanistan, in Arabia, in Persia, in Turkey, &c., with Indian cholera in order to support the theory of a westward progress of the malady. Had similar reports been collected from countries east of India, there would doubtless have been similar reason for assuming an eastward progress of the disease.

Amongst a mass of theory, two facts, as I regard them, stand prominently out. Firstly, that the incidence of cholera is on the most unsanitary localities; secondly, that cholera, in the guise of *cholera nostras*, and summer diarrhœa, is ordinarily present in most countries. I have elsewhere* recorded cogent reasons for my belief that *cholera nostras*, summer diarrhœa, and cholera, are the same disease. Continental delegates appear, however, to think that if cholera were prevented in India by sanitary work, there would be no necessity for sanitary work in their own countries, as there would be no cholera to guard against. I fully believe, however, that if there were no cholera in India, European epidemics would occur just the same, whether originating or revitalised in the utterly unsanitary towns and villages of the countries between India and Europe, or whether, as more probable, originating or revitalised as *cholera nostras* in unsanitary European places. Continental writers are fond of referring the origin of cholera to the shrines and places of pilgrimage in India. In former years cholera did frequently occur at these gatherings; but owing to careful sanitary preparation and arrangements, we can now safely say, cholera most probably will not occur. It is somewhat curious that, while certain authorities have not hesitated to urge the Government of India to adopt such measures as would practically stop pilgrimages in India, such a proposal as regards pilgrimages to Mecca has never been even hinted at. If sanitary measures were carried out at Mecca in the comprehensive manner they are conducted at large Indian pilgrimages, cholera would be exceptional at Mecca, as it is now at Hindoo shrines; and we should not have to lament that more than one-third of the pilgrims proceeding from Bombay, on the Haj to Mecca, never return. But the principal endeavours are devoted to preventing a possible danger from India.

Ordinary sanitary measures may be summed up as improved water supply, removal and disposal of filth, surface and subsoil drainage. Someone observed that morals differ in different countries, in different towns, in different streets, even in different Acts of Parliament. What is moral in London is immoral somewhere else, and *vice versa*. As with morals, so with sanitation. Sanitation, as sanitarians understand it in England, cannot be indiscriminately thrust on India—climate, soil, habits, customs, creed, ignorance forbid. Of the three ordinary sanitary requirements mentioned above, the supply of pure water is the only one generally applicable to India. Although much has been done in this respect, much more remains to be done, especially at railway stations and at places of pilgrimage. And I am sure I carry with me the sympathies of all educated Indians, when I say that punitive measures against those who defile water should be made more severe; for it has been shown, from the *shastras* and writings of Manu, that present customs with regard to water are at variance with ancient precepts. The second ordinary sanitary measure mentioned, *viz.*, removal and disposal of filth, cannot always be conducted in India as is supposed to be best in England. In large cities separation of sewage and storm water is essential. For no sewers adapted for fæcal matters would meet the occasional extraordinary fall of rain occurring in the East. On the other hand, unless there is plenty of water for flushing, which is not the case everywhere in India, sewer pipes soon become abominations. But the conservancy of small villages is perhaps the most difficult question of Indian sanitators, and I have already mentioned that I consider the public latrine system which has been instituted a mistake, for one reason, because it induces the people to make more "kulkuars" (private privies) in their own houses. As regards the third ordinary sanitary requirement, surface and sub-soil drainage, although the former is generally applicable, sub-soil drainage is not so generally applicable. Subsoil drainage is not applicable to those sandy countries where only a few inches of rain fall, for the sand immediately absorbs the rain like a sponge, and although it is damp and cold a very short distance from the surface, this would not be obviated by drainage, the moisture not being sufficient to escape from the holding sand by oozing. Subsoil drainage again, as pointed out by Surgeon-General Cornish, C.I.E., is not applicable to localities—as the Carnatic for instance—where they do not suffer from too much rain, but from excessive dryness of the

* "British Medical Journal," 1889.

soil. During the prolonged period of dry weather, subsoil drains become blocked by deposits of ants, lizards, rats, &c., so that when the drains are really required no water flows through. This, it may be said, is a matter of supervision, and so it is to a certain extent. But to ascertain the potency of any larger extent of subsoil drainage is no easy matter, and deposits of the kind mentioned occur very suddenly. As a matter of fact, when the Indian monsoon bursts, and heavy rain falls, many subsoil drains overflow.

I have made these remarks with the view of first showing to Indians that some sanitarians, at least, do not believe in the efficacy of thrusting British sanitation on India, without consideration of peculiar circumstances. And, secondly, with the view of showing those—chiefly foreigners—who appear to think that India can be easily sanitated on European lines, that this cannot be done.

The wholesale abuse which has been heaped on India, as the origin and home of cholera, owing to defective sanitation, is not deserved. From what has been written, one might imagine that the Indian air was what Voltaire scornfully called the atmosphere, "A blue and white mass of poisonous exhalations." And the habits of the Indians, although as respects personal hygiene especially very detrimental to health, are not, when climate is considered, so universally destructive as has been portrayed—remindihg one of Bishop Heber's description of the land where "every prospect pleases and only man is vile."

In the consideration of sanitary matters, as in the consideration of various other subjects, climate is not always taken into adequate account. But climate, as a factor of habits and usages in one part of the world that are incomprehensible to those living in other parts, plays a *rôle* that is not sufficiently appreciated and understood. Whether it be the question of diet, dress, or habit, climate exerts its influence in no uncertain manner. It is the Englishman's privilege to grumble, and it is the Englishman's privilege to run down and decry all things excepting his own personal possessions. The practice, like lawn tennis, cricket, racing, and wearing top hats, has been imported to India. I am quite sure that some of the unsanitary descriptions contained in Indian sanitary reports picture the worst instead of the ordinary conditions. As regards the requirements, which are, indeed, numerous, it is only right that such should be reiterated and again and again brought to notice, so that, when pecuniary means are available, they may be supplied. But these unsanitary descriptions, and these reiterations of wants, are what attract the notice of those who believe in India being the home of cholera, and in the conveyance of the disease to Europe from India. What has been done is not brought out sufficiently prominently: and I look forward to its being demonstrated at future Congresses that India is not so much behind in sanitation as is generally believed. It is not so very long since Dr. Acland observed that the labours of the Indian Sanitary Department have equalled the best work in any country.

At the close of the Congress, Sir William Wedderburn proposed the following resolution, which was seconded by Sir Douglas Galton:—

"That, looking at the interest shown by India in the Hygiene and Demographic Congress, and considering the probability that other tropical countries and colonies would take a similar interest in future Congresses, if a more prominent position were given to the consideration of subjects in which they are specially interested, this meeting recommends to the Permanent Committee that, in future Congresses, a Tropical Section be formed, with a view to a more full discussion of questions affecting sanitation and the origin of disease in tropical countries."

The first idea was to form an Indian Section, but this was, necessarily, soon given up, because it was felt that, when the Congress meets in other countries, the interest felt in India would not be sufficient to justify an Indian Section. But a Tropical Section is different, because other countries have tropical possessions, the sanitation and diseases of which might well be compared with those of India by delegates at future Congresses.

DISCUSSION.

Surgeon Lieut.-Colonel HENDLEY, C.I.E., said it had been said that the Government of India might have done more for the Hygienic Conference by deputing paid experts from India to attend the discussions, but the paper just read had sufficiently disposed of that objection, and he thought neither the Secretary of State, the Press, nor the taxpayers would have supported any such expenditure of public money. The Congress was intended, in the first place, to sum up what had been done in the past, so that it might be of use in the future, and also to popularise the subject of Indian hygiene; and he thought the money which would, in that case, have been spent might be better employed in future in holding small congresses of engineers, and medical and civil officers, such as Sir Edward Buck had held

from time to time, for the Agricultural Department, in various parts of India. A good deal might also be accomplished by affording facilities to medical officers to go about and see what was done in other large towns. He had found this of very great use in suggesting schemes for the sanitation of Jeypore. Frequently, in India, very much was done over and over again for want of a little knowledge. Sir William Moore had somewhat criticised the paper he read at the Congress with regard to the present condition of the native capitals and large towns of Rajpootana, but he (Dr. Hendley) might say that he wished to accentuate the good which had been done in the native States, chiefly by the support of the native princes themselves. But though an immense deal had been done there was still an immense deal to do. Though very great improvements had been made in the capital towns, in the suburbs and country towns things were nearly as bad as before. In some of these towns there were 30,000 or 40,000 people, and nothing whatever had been done. Twenty-one years ago he went to Rajpootana, and served under Sir William Moore, and no one was better aware of the immense deal of good which had been done under Sir William's advice than himself, and he looked upon him as the father of sanitation in that province. As regards the wells in Jeypore, sweet water was found in many of them outside the towns, and in some within the large towns, yet within 200 or 300 yards of these there were wells containing very saline water. A proof that the saline water was due to the insanitary habits of the people was found in the fact that many of the old towns were said to have been abandoned principally because the water had become foul. When these towns were first built the water was sweet. With regard to the prisons, great advances had been made in Rajpootana, but still in outlying places defects existed. Only ten years ago he saw in a jail a chain on the floor, which was used every night to fasten the prisoners together; and he knew of one or two places where men and women, although not actually living in the same cell, were quartered in cells which opened into the same yard. It had been suggested that the *hakeems*, and *baids* might have been called in to give their opinion; but, as practical sanitarians, they knew that nothing would ever come of such a suggestion. The other day, a civilian, who had been a commissioner, told him that, when the *hakeem* in a large native capital died, the son, who had only been practising the profession two or three years, was installed in his place. A good many people objected that he had no knowledge, but it was said that did not matter, as his father had had sufficient for him, and things would go on as well as ever. One of the great deficiences was the want of good subordinate officials. The Prime Minister of Jeypore told him that it was almost impossible to do much good in the villages, because there were no subordinates who believed in the efficacy of sanitation, and who were sufficiently educated to carry out the orders of the durbar. Some attempts had been made to educate these men, but it was a very difficult task; and he feared civil surgeons would find it almost impossible, so much of their time being taken up in other work. There was a tendency now to employ them in matters of detail, leaving them very little time to look after the health of the general population. In some quarters it seemed as though far more attention was paid to criminals than to honest people; and when a man had been spending three or four hours in petty details in a prison, even weighing the prisoners, he had not much inclination to lecture on sanitation. He thoroughly agreed, in the main, with Sir William Moore, and especially that not enough credit had been given to the officials of the Government for the enormous strides which had been made.

Sir DOUGLAS GALTON, K.C.B., F.R.S., as President of the Organising Committee of the International Congress, said he had listened with great pleasure to this paper, summarising so well the work done in the Indian Section. He thanked Sir William Moore for the care he had taken to answer the objections of foreign sanitarians on the origin of cholera in India, and its extension from India to Europe. It was quite certain that we were suffering very much from the fact that the great improvements in sanitation which we have accomplished in India during the last quarter of a century have drawn attention to the sanitary conditions of that country, and have led foreign sanitarians to fix on India as the birthplace of cholera, and to remain contended with their own insanitary conditions, and make use of India as a reason why they should not improve their own towns, but should rather endeavour to oppress our trade by means of quarantine. Some few years ago the Government of India adopted a measure which he thought would have a very far-reaching effect on the improvement of sanitation in that country, viz., the creation of Sanitary Boards in the different provinces; and that morning he had been looking throngh a series of reports, now in the India-office, from the various provinces, on the work of those Boards, showing the places in which they had been established, and the places where they were just commencing. What struck him was that these Boards had chiefly hitherto confined their work to the municipalities rather than to the village populations; and considering that villages in India in some provinces numbered hundreds of thousands, and that some of these were very large, and that therefore an enormous population was concerned, it was to be hoped that the Sanitary Boards would turn their attention to this matter as soon as possible. Village sanitation really meant guarding carefully the water supply, cleanliness, and conservancy, rather than constructing expensive works such as many of the towns and municipalities required. In conclusion, he thanked Sir William Moore for his valuable paper.

Surgeon-General CORNISH said he agreed with the views put forward in the paper. For many years he had been Sanitary Commissioner for the Presidency of Madras, and afterwards Surgeon-General and Chief Sanitary Officer, and it fell to his lot to ascertain the condition of the people. There could be no question that complete provision had been made with regard to the sanitation of the towns in the Municipal Bills of 1884, but the sanitation of villages had yet to be taken up. Before he left India he was a member of a committee for revising the Local Board Acts, which were revised in 1884, and passed. With regard to the Presidency of Madras, arrangements were made for the union of villages covering a certain area and population for purposes referred to by Sir Douglas Galton, keeping the water supply in a pure state, and cleansing the villages, but he did not know how the Act regarding the union of villages had worked —he feared rather badly, because the people were not yet ready to take advantage of the power they had of collecting money for the purpose of cleanliness. It was a work of time to make them understand the great importance of these things, but no doubt some day the people themselves would become as interested in their own sanitary condition as their rulers were. Anyone who had a knowledge of the people of India knew it took a long time to get into their heads the notion that filth and the pollution of water were injurious.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., said that Sir William Moore had given them an admirable *précis* of the work of the Indian Section of the late Congress of Hygiene and Demography, and had not only conferred a great favour on the Society of Arts in preparing it, but had done a great service to the Congress; and he hoped that the Council of the Society would sanction the presentation of a large number of copies of the *Journal* of the Society in which the paper appeared, to the Secretary of State, for distribution with the volume of the Report of the Congress relating to India, throughout that country. Regarding the subject of the paper, he was not entitled to offer any criticisms; but both Sir William Moore and Dr. Hendley had been rather sweeping in their condemnation of Hindu medicine and hygiene, and he took the opportunity to offer a few remarks of respectful protestation against their apparent prejudice on these points. Medicine was not a science, but an art, the successful practice of which depended very much on the personality of the artist, and the patients' faith in him. On his first appointment to the medical charge of a native regiment, he gave his patients the option of having in a native *vaid* to attend them; and, at that very moment, it had come into his recollection, that in taking charge of the hospital of the 3rd Bombay Native Infantry at Sholopore, in 1855-6, a *havildar* was transferred to his care dying of fever. Every attempt to produce perspiration having failed, he at once consulted the man as to his wishes, and he said, "Stop all this English treatment, and call in one of our own *vaids*." He did so, and within twenty minutes of the initiation of the prescribed incantations, the patient broke out into a profuse perspiration, and rapidly became convalescent. Dr. Hendley had whispered to him that had he waited twenty minutes he would have saved his own credit. So be it; but, after that, he always took free advantage of the experience of the *vaids*, and, when ill himself, always called one in. They amused him, and stuffed him with all sorts of out of the way lore; and, as he had no faith whatever in therapeutics proper—except in the etymological sense of the word—he certainly got as much benefit from them as he would have received from any English practitioner. On the other hand, he had the strongest confidence in Western surgery and hygiene. But, even with regard to the latter, the Hindus could teach us some lessons; in the disposal of their dead by cremation, for instance. The practice was repugnant to Western sentiment, but, from a scientific point of view, it was preferable to burial. He was also not indisposed to defend the Hindu practice of *sati*, or widow burning, and infanticide. The net result of our sanitary improvements in India had been to enormously increase the population; and the worst of all insanitary products was a superfluous human being. This question of the prodigious increase of the population, both here and in India, would, at a no distant future, have to be frankly faced and ruthlessly resolved. The true ideal of sanitation was not a reduced death-rate, but the highest health, wealth, and happiness of the living mass of able-bodied and capable working adults.

Lieut.-Colonel A. T. WINTLE, late R.A., suggested that the word hygiene ought to be defined. He had studied the question for some years, and, from what he had read, he gathered that there was a good deal of difference of opinion about it. To him it meant simply pure air, pure water, pure food, and being temperate in all things; but some included vaccination under hygienic measures, though, according to the highest authorities, vaccination meant the introduction of a poison into the system.

Sir GEORGE BIRDWOOD protested against anti-vaccination theories or any other fads being introduced into the discussion, or there would be no end to it, and these could only be discussed properly by medical men.

The CHAIRMAN hoped Colonel Wintle would confine his remarks to the subject of the paper.

Lieut.-Colonel WINTLE suggested that something might be learned from the old writings of the Brahmins, whose moral philosophy, according to Sir W. Temple, consisted in the prevention of all diseases, from which they imagined all perturbation

of mind arose, and who considered it a disgrace to be ill. He belonged to the Vegetarian Society, which advocated hygiene, and he had, like others, found out the secret of health for himself under somewhat trying circumstances; but they were teaching a doctrine which, according to the ordinary acceptation of the term hygiene, was harmful to the State, because they taught that vaccination was injurious, whilst they sought to encourage self-denial and all the higher moral qualities. He believed they were all aiming at the same result, though they differed as to methods.

The CHAIRMAN said he had never heard a more clear or concise paper than the one now read, and he had really very little to add to the discussion on it. As Chairman of the Indian Committee of the International Congress, he could corroborate all that had been said by Sir William Moore with regard to the prominent part taken by the Indian Section, thanks mainly to the indefatigable exertions of Mr. S. Digby, the encouragement given by Sir Douglas Galton, and the hearty response made by the Government of India and the official and non-official classes to the appeals addressed to them. The native princes, moreover, gave practical proof of their interest in the Congress which had, on its part, been of great value to India. An interesting account had been given by Sir William Moore of the progress of sanitation in India, and he quite agreed with him that there were no three large cities in Europe in which greater advances had been made than in Bombay, Madras, and Calcutta, while there were numbers of towns and villages in India which would compare favourably not only with the towns and villages on the continent but with those in England. He could himself look back to the time when both Europeans and natives depended for their water supply on putrid tanks and filthy wells; but now, if he was correctly informed, to the principal towns and villages a supply of pure water came through pipes from well-built reservoirs; and from this reform alone there had been a large decrease in the death-rate. No doubt much remained to be done, but it was reassuring to remember that taking the Europeans troops alone, while some thirty years ago the death-rate was 69 per 1,000, it was now only 14; and the death-rate in the civil population showed equally good results, arising chiefly from sanitary precautions. Both as a Society and as individuals, they should do all they could to strengthen the hands of the sanitary authorities in India and at home; not by making exaggerated misstatements so common in this country on such matters, but in interesting and educating the public mind, as the reader of the paper had done, by careful statements of fact. He was disposed to agree with Sir William Moore that the abuse which had been heaped on India, as the origin and home of cholera, was not altogether deserved. It was in no way proved that the heavy epidemics which afflicted this country in 1848, 1855, and 1865 came from India. On the other hand, it had been shown by Sir Joseph Fayrer, in his presidential address at the recent Congress, that it was not cholera but fever which was the prevailing disease in India; for while the deaths from cholera in a certain typical year named only amounted to about $1\frac{1}{2}$ per cent. in the European troops and 4 per cent. in the civil population, the deaths from fever were 5 per cent. amongst the former, and 17 per cent. in the latter. It was, therefore, rather hard to accuse India of being the home and hotbed of cholera, and to assert that cholera in Europe always came from India. He concluded by moving a hearty vote of thanks to Sir William Moore.

The vote of thanks having been carried unanimously,

Sir WILLIAM MOORE, in reply, said he was quite aware that chains were formerly used in jails in the native States; he had seen them many times, but he did not know of any jail in which men and women were kept together at night. Sir Douglas Galton had referred to the Sanitary Boards recently instituted, and though he (Sir William Moore) had not mentioned them in the present paper, he did so in the paper he read at the Congress, and referred to the benefits likely to accrue. It was probably quite true, as Surgeon-General Cornish had said, that much remained to be done with regard to the sanitary condition of the villages in Madras, and in Bombay also; but Bombay was rather better than Madras, and always had been. The cases mentioned by Sir George Birdwood he should describe as instances of faith-healing; and though Sir George Birdwood did not believe in medicine, he thought, if Sir George took a considerable quantity of quinine, he would find his head buzzing; and, if he took plenty of Epsom salts, something else would happen. To his remarks on infanticide and suttee, he might have added the burial of lepers; and, though he (Sir William Moore) did not like to say much about it, he might say that, if it were desired to reduce the population, some effect might be produced by stopping the use of opium. Colonel Wintle wished to know what hygiene meant. He presumed it meant the health of the body personally; and sanitation meant the health of the country generally. He did not think much useful information could be obtained from the old writings of the Brahmins, as they would not have anything to do with sick people or hospitals for fear of pollution. With regard to water, there had been hundreds of thousands of wells either rebuilt or repaired and thoroughly cleansed within the last decade or two. Two great obstacles to sanitary progress were, on the one hand, the exaggerated statements which had been referred to, and, on the other, the impracticable suggestions made by some sanitary officers, which they knew could not be carried out.

Colonel THACKERAY, R.E., C.B., V.C., added, as showing the advance which had been made in sanita-

tion in India, that some years ago, in his experience, one regiment alone lost 200 to 300 men from cholera, and two years after it lost 400. In 1867 200 men, women, and children died in a month from the same disease; but now cholera was almost entirely stamped out amongst the troops through the improved accommodation which had been provided.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 9, 1892; Professor W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Chase, George B., 234, Beacon-street, Boston, Mass., U.S.A.
Formoy, James Arthur, Lestelle, Forest-hill, S.E.
Goodridge, Captain John James Lewis, Portswood, Southampton, Hampshire.
Mallet, Robert Trefusis, 1, Philbeach-gardens, South Kensington, S.W.
Wye, Thomas Henry, Brooklands, Leytonstone, Essex.

The following candidates were balloted for and duly elected members of the Society:—

Blanchard, Mark Henry, Bishop's Waltham, Hants.
Courtenay, J. Irving, M.A., 1, Essex-court, Temple, E.C.
Farlie, John Burke. 128, Eglinton-road, Plumstead, Kent.
Goodenough, Lieut.-General William Howley, C.B., Blomefield-house, Shooter's-hill, Kent.
Langton, Alfred, Deptford Pier, S.E.
Macpherson-Grant, John D.L., Ballindalloch, N.B.
Wells-Smith, Henry, 8, Norfolk-row, Sheffield.

The paper read was—

ON THE DURABILITY OF MODERN PIGMENTS IN OIL.

By A. P. LAURIE, M.A.

Professor Church, in his recent book on the "Chemistry of Paints and Painting," has drawn up a selected palette of twenty-five pigments suitable for oil painting. He divides them into two groups.

Section I. contains:—

Flake white.	Vermilion.
Cadmium yellow.	Madder carmine.
Cobalt yellow.	Light red.
Yellow ochre.	

Viridian.	Raw umber.
French ultramarine.	Cappagh brown.
	Ivory black.

Section II. contains:—

Raw sienna.	Purple madder.
Naples yellow.	Madder brown.
Baryta yellow.	

Green oxide of Chromium.	Cobalt blue.
Terre verte.	Prussian blue (insol.).
Malachite.	Burnt sienna.
Emerald green.	Caledonian brown.

This selected palette is the outcome of many years of experimenting, and of useful observation of the behaviour of pigments. It is also, I believe, sufficiently complete to supply all that is needed in painting a picture. On the other hand, it cannot be regarded as final. Doubtless, as our knowledge increases, certain pigments will be excluded from this list, and others introduced. It will be necessary to subject it to a careful and detailed criticism from time to time. It has seemed to me, however, better to confine myself to this palette than to conduct experiments over the whole range of pigments, although there are pigments which have been excluded, and which are worthy of another trial.

Among the reasons for doing this, I may point out that there is a tendency to useless repetition in the experiments on this subject, and to proving again and again that certain pigments are fugitive. Surely the fate of certain colours has been finally settled, and they need be no further considered.

I have also been limited in range by the fact that I have set myself to prepare most of the pigments experimented upon, and to prepare them in such a form that they should be equal in colour, &c., to the commercial specimens. The importance of doing this is obvious. We can only hope to arrive at accurate knowledge on this subject by preparing the pigments experimented upon, and knowing their history and what they contain.

This is a most laborious task, however, as published recipes are almost useless, and months of experimenting were usually necessary before a single pigment mentioned here could be satisfactorily produced.

In order to make the paper complete, the recipes used in the preparation of the pigments should be published in full. This is impossible at present, though they are all carefully recorded, and will ultimately be made public.

This paper then is merely a few notes on Professor Church's palette, not pretending to exhaust the subject, and to be added to, from time to time, as fresh results are obtained.

Let us begin our illustration of this palette by selecting from it the pigments which require careful preparation and careful testing before being finally included. They are—Cadmium yellow, cobalt yellow, vermilion, madder carmine, French ultramarine, Naples yellow, baryta yellow, purple madder, madder brown, malachite, emerald green, Prussian blue—all these pigments are artificial, except malachite, which is of little importance; and much will depend on the method of preparation, careful washing, exclusion of dangerous impurities, and freedom from gross adulteration. The other pigments in the list are permanent, if genuine; and therefore all that is necessary is to look out for adulteration.

To take, then, the yellow pigments mentioned in the first column, and to begin with *Cadmium Yellow*, careful readers of Professor Church's book will find that he refers to only one shade of this yellow as being perfectly safe, an orange-yellow shade. The pale cadmiums are notoriously fugitive, and contain free sulphur, while the deep orange cadmiums seem apt to change into the yellow varieties.

I have been trying, myself, to obtain a cadmium of a pure light yellow, which shall contain no such objectionable constituent as free sulphur, and shall also be molecularly stable. I have been preparing some lately which I subject to a dull red heat before grinding. This ought to increase molecular stability, and would, of course, prove destructive to pale cadmium, made the usual way. I do not feel justified in publishing the process as yet, but I think the pigment is worthy of a trial, as it ought to be stable.

Cobalt Yellow (*Aureoline*).—This pigment (a nitrite of cobalt and potassium) I have prepared from a recipe very similar to the one given by Professor Church. I find, after thorough washing, and grinding in oil, that it is not affected by twelve months' exposure out of doors towards the south; so that, as far as my tests go, I can confirm Professor Church's good opinion of it.

Yellow Ochre.—I have recently had my attention directed to a most objectionable adulteration of yellow ochre with lead chrome yellow. Out of seven samples of "Oxford ochre" sent me by wholesale dealers in pigments, two contained chrome yellow. One of the two consisted very largely of whitening, tinted with chrome, and mixed with a small quantity of a pale ochre. The result was a sample which looked as bright as the best samples of genuine Oxford ochre. Professor Church mentions adulteration with yellow lake—I have never yet met with a case of this.

Vermilion. — I have described at length elsewhere my experiments on this pigment. I find many English samples to contain alkaline sulphide, and prefer genuine Chinese vermilion. The following are the per-centages of ash found in different samples of Chinese vermilion obtained direct from China :—

(1)	(2)	(3)	(4)	(5)	(6)
·1	·1	·06	·12	·06	·04

Some of the English vermilions can be very much improved by washing with weak acid, as the following analysis shows :—

Ash before washing	·52	per cent.
,, after washing	·14	,,

All vermilions, including the best Chinese vermilion, blacken in sunlight, but are, I believe, stable pigments when exposed to the diffused light of a room or gallery.

Madder Carmine.—The madder lakes I have experimented on are of my own making, and are prepared by dyeing well washed alumina with artificial alizarine, and again thoroughly washing. I have prepared a purple, a ruby, and a rose madder. After a year's exposure, the purple has, possibly, lost a little, the ruby is unchanged, and the rose has very slightly faded, and become purpler in tint. They are all, practically, unaltered, but with a slight advantage in favour of the ruby madder.

The only other pigment open to question in this palette is French ultramarine. I have not made any experiments on this pigment, and shall therefore pass to Section II.

Naples Yellow.—I find no difficulty in preparing a real Naples yellow, that is a compound of oxide of lead and antimony of a fine colour, but have not exposed it for a sufficient time to test its durability.

Baryta Yellow, or Lemon Yellow.—Professor Church points out that lemon yellow is often a strontium, not a barium chromate, and that the barium chromate is much the most permanent of the two. I have, therefore, only experimented on the barium chromate, preparing it myself. It seems to me to lose slightly in brilliancy after twelvemonths' exposure. As

lead chrome and Prussian blue are known to be mutually destructive, I thought it as well to test a mixture of barium chrome and Prussian blue. I find that a bright green is produced, which is only slightly dulled by twelve months' exposure. Here and there the Prussian blue seems to have faded, causing the yellow to show up through it a little more, but they do not seem to have any injurious action on each other.

Purple madder I have already referred to; and I have not tested *Brown Madder* of my own making, for a longer period than six months; for that period it was not affected.

The two next pigments of doubtful stability are malachite and *Emerald Green*. Malachite is so little used that I have not experimented on it. I have described elsewhere the property which emerald green possesses of slightly dissolving in the linseed oil, and slowly diffusing through it after it is dry. It is, of course, fatal both to cadmium yellow and vermilion, turning them black. For this reason, I think it is better rejected, or, if used, only occasionally by itself, and far away from any cadmium yellow on the picture. I should advise the introduction of cobalt green into the palette. It is a durable and beautiful pigment.

Prussian Blue.—It is very difficult to try Prussian blue that has been properly washed. It is apt to contain as much as ·3 per cent. of free sulphuric acid, and often large quantities of potassium ferrocyanide. English makers are, in my experience, peculiarly careless; and I find it best to buy Prussian blue in Germany. It is troublesome to make. The blue I have obtained from there never contains more than ·01 per cent. of free acid, so that it is easily washed sufficiently. I have had some of a perfectly washed blue exposed for twelve months. I find it has faded somewhat, and become greener in tint. It must be remembered, however, that, in the dark, Prussian blue recovers; so that it should be stable in an ordinary room. I find it may be mixed with cobalt yellow with impunity. All the other pigments in this palette are of undoubted stability, and are above question.

In the course of these notes I have referred more than once to the effect of light on these pigments. My method of testing this was as follows:—I selected an attic window looking nearly due south, and I hung outside it a wooden frame, into which I could slide glass plates (half-plate size). After preparing, washing, and drying a pigment, I ground it in pure cold-pressed sun-refined linseed oil, and rubbed it out on two glass plates, getting the two patches of colour to look as nearly the same as possible. I put them both away to dry, and after they were dry I slipped one plate into the frame and put the other away into a plate box. In this way the plate outside was exposed to all the weather and sun for twelve months, from September to September. The pigments tested were:—

Twelve Months.

	Ruby madder....	Unchanged.
	Rose madder	More purple, very slightly faded.
	Purple madder ..	Perhaps very slightly faded.
	Cobalt yellow....	Unchanged.
(Barium)	Lemon yellow ..	A little duller.
(Chinese)	Vermillion	Black, or dirty brown.
	Prussian blue....	Faded, greener.

Six Months.

Brown madder ..	Unchanged.

These tests were of such exceptional severity, the exposure being outside, that I do not think any of these pigments should be removed from the selected palette, as they have practically (with the exception of vermilion) proved permanent. The reasons for not distrusting vermilion have been given elsewhere. As far then as my experiments have gone, I should only exclude emerald green from this palette, provided the pigments mentioned are properly prepared, and with such restrictions, as the avoidance of impure vermilion and of pale cadmium yellow, as at present manufactured. Of the other pigments, the most effected by exposure (after vermilion) is Prussian blue. Of the other blues of course cobalt blue is perfectly safe, but French ultramarine requires careful testing.

On the whole, however, this palette seems to me a very trustworthy one, and not at present open to much improvement. There are, however, various pigments excluded which are worthy of further trial, and may ultimately be re-introduced.

In all these experiments the pigments have been merely ground in pure oil. Different vehicles have a powerful influence on the durability of many pigments, and are worthy of special study. I have treated of this, however, at considerable length elsewhere, and need not repeat my experiments here.

The results may be briefly summed up as follows:—Linseed oil is permeable by moisture and gases, and consequently affords poor protection to pigments liable to be affected by moisture or certain gases.

The dissolving of resin in the oil, so as to make oil varnishes, such as copal oil varnish and amber oil varnish, has little or no effect in protecting the pigments, the moisture still penetrating.

Pure resin, when made into vehicles by solution in volatile liquids, and natural varnishes or balsams, such as Venice turpentine, *oleo de abezzo*, and others, do protect very effectively, excluding moisture and gases, and enhancing the durability of the pigment under adverse conditions.

(This probably accounts for the durability of most coloured lacquer work from Japan, when natural varnishes are used; and there is some historical evidence to show that balsam was largely used by both Flemish and Italian painters on vehicles.)

Certain pigments are soluble in linseed oil. For instance, verdigris is readily, emerald green slightly, soluble. Such pigments diffusing through the oil may be very destructive.

They are not soluble to the same extent, if at all, in resin. These results, though of little practical application at present, may, I hope, lead to the discovery of an improved medium, which will protect and isolate pigments ground in it, and so add to the durability of pictures.

DISCUSSION.

The CHAIRMAN said there were two aspects in which this question of the permanency of pigments might be considered—their interaction among themselves, combined with the action of sunlight upon them, and the exceedingly severe test to which they were subjected in the atmosphere of great cities, and of London in particular. The present state of London statues illustrated very forcibly the severity of our climate. The art of painting and of sculpture were very closely related, and in the past, Italian artists took enormous pains to get a composition into their bronze which should enable it to assume very delicate shades of colour. A little lead in the presence of the copper and tin alloy, known as bronze, enabled it to take a beautiful velvet coat. It was absolutely useless to try in the London atmosphere to make a composition of bronze that would turn any colour at all, except a black one. Take the equestrian statue of Lord Napier of Magdala, in Waterloo-place, opposite the Guards Memorial. Last year the layer of patina upon its surface was taking on a velvet coat; he watched it with the greatest interest all through. A fortnight ago a black-greenish tint had formed over both the soldier and the horse, and a little while after that very unsightly stains might be seen running over the whole statue, and now there was none of that delicate velvety brown tint which ought to be there. Indeed, the warrior seemed, by his very attitude, to recognise the fact, for he was turning, field-glass in hand, away from the Athenæum Club, as if perfectly conscious that in the present state of the London atmosphere he was beyond the aid of science, and that he would soon become sooty black like the unfortunate occupants of the adjoining pedestals. In the old days secrets were handed down from master to pupils; and was not that after all the reasonable way? Was it wise, in the present state of British art, to place in the hands of every votary the power of painting absolutely permanent pictures? Should there not be some kind of natural selection, which would enable only those who had established their right to enduring fame to use the excellent materials which Mr. Laurie had placed at their disposal. That, however, was not the question before them. They, as members of the Society of Arts, had to take care that the best materials were placed at the disposal of artists. Now he knew but little of art, but he had the good fortune to live a good deal among painters, and he was often, as a chemist, astonished at the utter recklessness with which they combined their colours, and at the general appearance, from the chemist's standpoint, of the palettes after a morning's work, and it was only by bringing home to artists little by little the criminal nature of such procedure, that they might hope to attain better results.

Mr. F. SHIELDS asked whether, in regard to the action of sulphuretted hydrogen in turning chrome yellow black, the lecturer had tried the effect of strong electric light in reproducing the yellow colour, after it had been turned black. He imagined, as the arc light was extremely strong in active rays, that, after the exposure of a few hours to a strong arc light, one could definitely decide whether it were likely that the colour would be restored by sunlight. In the case of white, the electric light restored the colour sooner than the sunlight; at least, such sunlight as they were able to get in the neighbourhood of London. His attention was first directed to this matter through some experiments tried by a friend in connection with phosphorescence.

Mr. LAURIE said the suggestion had not occurred to him, and it seemed a very good one. He always made his experiments twelve miles out of London, and at least 400 feet up the top of a hill, so that he got a little more light than could be got in London. He always, too, exposed the pigment not only to twelve months' sun, but also to all the weather.

Mr. WALTER FIELD said it would be useful if they could know where to get this balsam which was better to mix with the pigments than linseed oil.

Mr. LAURIE said it was balsam of larch which he employed. He did not think it could be got at

present. He obtained it from the Black Forest. It was not an article of commerce, though it might easily become one, because there was plenty of it. They might, perhaps, get it through a London drysalter; but, as he explained in a former lecture, though it was a point of great interest, it was of but little practical importance. One could not make a medium out of it which an artist would look at, because it was sticky, like Canada balsam. Then it was brittle, and apt to crack. Probably a mixture of linseed oil —more oil, with some pigments, and less with others —would represent the ideally perfect thing; but, if the balsam was introduced into pigments in large quantities, artists would not touch them. It was at present rather a point of theoretical interest, but it might lead to something better being found out.

Mr. WOLLASTON wished to ask whether it would not be possible to produce a vermilion, by the aid of hydrogen sulphide under pressure, so as to avoid the alkaline sulphates.

Mr. LAURIE said these Chinese vermilions were prepared by sublimating the sulphur and mercury together, and then one got the red sublimate on the top of the crucible; but he had not the faintest idea what would be produced by acting upon mercury and hydrogen sulphide under pressure.

The CHAIRMAN said it was well known alloys could be built up in that way by simple contact of metals under pressure, and there was every reason to think that sulphide might be formed if the pressure was sufficiently powerful.

In responding to the vote of thanks,

Mr. LAURIE, said he had hoped there would have been a little more discussion, though probably the paper did not lend itself to that. The remark they had heard as to the formation of hydrogen sulphide under pressure was interesting, at least from a theoretical point of view, because the black sulphide and the red sulphide were of the same composition—the difference being due to their different molecular states, and the fact that this sulphide is formed under pressure might have some bearing on that question. It would be very interesting to take mercurie sulphide prepared in this way, and test its durability against some others, the qualities of which in this respect are known. He had not described the actual receipts used in making the pigments, and they would perhaps hardly expect him to do so. He hoped the time would come when all good receipts for making such pigments would be published. All his receipts had been very carefully recorded, and he hoped the day would come when he might put them into print with the experiments. He wished artists would prepare their own pigments, and then they would not be afraid to publish their receipts. Meantime, receipts by which pigments could be made had a definite commercial value to him, as well as to anybody else. He was therefore in a half and half state—half the pure man of science who publishes everything, and half a commercial man who does not like to tell everything he knows. He hoped, however, soon to get his wings to fly into the pure scientific atmosphere, and to publish everything.

Mr. C. NAPIER HEMY, Churchfield, Falmouth, writes to the Secretary:—Thank you for your invitation to attend Mr. Laurie's lecture; I only wish it were possible. I read with the greatest interest his last paper in the *Journal*, and hope his paper of next Wednesday will find a place in its pages also. I have just been twice through Vibert's book, and am using his varnishes, but do not like doing so, as he does not tell us what they are made from. I was a pupil of Baron Leys, and there in Antwerp we used a medium called "zack," but Alma Tadema will be able to tell you about that. I had many talks with Baron Leys and certain French painters about pigments and mediums. I think if many painters would give us their personal experiences in a short form, it would be most helpful from one point of view at least. What artists want is something nice to paint with, so one takes Roberson's (pomatum) medium, and his picture goes yellow and dirty, and looks as if it had been buttered; another takes copal varnish, and it cracks; another, amber varnish, and the work gets horny or blooms; another, turpentine, and it goes dull; and so on. Now this question of mediums is far more important than that of pigments, and has far more to do, not only with the way a picture is painted, but how it stands. But the question of questions is, not the medium, nor the colours used, but the way they are put on to the canvas; not only the workmanship itself, but the quantity of medium and colour used. A glass of port may do a man good, but it does not follow that a whole bottle will do him more good. We use too much medium—too much oil or varnish, I mean; and instead of taking off the paint when we have gone wrong, we work over and over, and every coat of paint is a new danger. What a good thing it would be if every painter would write on the back of his picture the colours and mediums used in painting it, and where purchased; this would be some help. Though, as Leys said, it is, after all, the way a picture is painted, and not the colour used, which has to do with its durability.

Miscellaneous.

RUSSIAN TEXTILE INDUSTRIES.

The French Consul at St. Petersburg, in a recent report, says that manufacturing industries in Russia

have all experienced a considerable development during the last quarter of the century. Dating from the abolition of serfdom, the principal industries have made such an advance that they are now able to supply all the requirements of the home markets, and the importation of manufactured articles is becoming less every year. It is particularly the textile industries which have benefited by this movement, and these have now become one of the most important branches of the manufacturing interests of the country. The number of spinning mills and cloth factories, which, in 1885, amounted to 2,726, increased in 1889 to 2,979, while the production rose in value from 410 million roubles to 522 millions. In 1885 there were 336 establishments for the production of cotton goods, whose outturn was valued at 55 million roubles; in 1889 there were 534 factories, with a production valued at 68 millions. Silk goods realised 9 millions of roubles in the former year, and 12 millions in the latter. Woollen cloths were produced to the value of 42 million roubles in 1885, and 43 millions in 1889. Until within a very recent period, the cotton consumed in the Russian manufacturing establishments came from the United States of America, but the energetic measures adopted by the Russian Government with the view of developing the cultivation of the textile in Turkestan and the provinces of Central Asia have produced good results, and, for some time past, the cotton grown in these districts has taken the place of the foreign article. In 1888, 1,054,955 pouds (poud = 36 lbs. avoirdupois) of cotton were brought into Russia over the Asiatic frontier, and in 1889 1,459,808 pouds, valued at over 10,000,000 roubles. During the same period Egyptian cotton entered into competition with the American raw material. While the imports into Russia from Central Asia and Persia, of cotton, amounted to more than 1,500,000 pouds in 1889, this quantity was considerably increased in 1890; and from this it is deduced that the production of Russian cotton will be called upon in the future to play a very important part in the economy of the country. It is through the custom-house of Astrakhan, that this textile is introduced into Russia, where it is sent to Moscow or Warsaw, or direct to the spinning establishments. Foreign cotton enters through the ports of Reval, Liban, St. Petersburg, and Odessa, but it is principally to Moscow and Warsaw that the greater part of it is consigned, these two markets being the centres of the great cotton industry. The Governments of Vladimir and Moscow absorb half of these supplies, and the remainder is taken by Petrokovsk, St. Petersburg, and Esthonia. The largest number of spindles and looms are found in the province of Moscow, amounting respectively to 847,734 spindles, and 139,226 looms; St. Petersburg has 767,828 and 8,966; Vladimir, 554,148 and 3,606; and Petrokovsk, 505,715 and 10,127. The annual value of the production in Vladimir is estimated at 69 million roubles; in Moscow, 62 millions; in Peterovsk, 39 millions; and in St. Petersburg at 26 millions. It has been remarked that the large cotton manufacturing establishments of Moscow have recently opened shops for the retail sale of their goods in that city. This has been done with the double object of selling their goods for cash, and of showing the excellence of their goods, and of the favourable comparison they will bear with foreign products. The articles chiefly on sale are nankeens, satinettes, zephyrs, and cotton tissues used in upholstering.

Notes on Books.

HEINEMANN'S SCIENTIFIC HANDBOOKS: GEODESY. By J. Howard Gore. London: William Heinemann.

The author, in an opening chapter, deals with some primitive notions as to the form of the earth. The Hindoos held it to be hemispherical, and like a boat turned upside down resting upon the heads of four elephants, which stood on the back of an immense tortoise. Another view was, that the earth was formed like an egg, and floated in the ocean as in a basin. Gradually, some guesses, more or less true, as to the size of the earth were made; but it was not until the beginning of the 17th century that any accurate determinations were set out. It is to Willebrod Snell, the famous astronomer and mathematician, that the honour is due of initiating the system of triangulating from a known base. Mr. Gore gives, in his successive chapters, an account of the work done by Picard and Newton, of the continuation of spasmodic geodetic operations, until, in the 18th century, geodetic work was taken up in earnest, both in England and in France. A chapter is devoted to an account of the "Great Triangulation of India," set on foot by Lambton, and carried on by Everest, Waugh and other distinguished engineering officers. In the last chapter is given a sketch of the progress of geodetic work in the United States.

General Notes.

NORWAY AT THE CHICAGO EXHIBITION.—Information has been received from the Secretary of State for Foreign Affairs, by the Secretary of the Royal Commission, that the Storthing has voted £117,000 towards the expense of representing Norway at the Exhibition. The grant includes the sum of £2,775, which is to be expended in assisting handicraftsmen and other representatives of industry, &c., to visit the Exhibition. The Government has reserved the right of approving the designs for stands and cases in order that Norway may be worthily represented in regard to national art.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

March 16.—Tempest Anderson, M.D., "Iceland." Prof. Clement Le Neve Foster, D.Sc., will preside.

March 23.—Gilbert R. Redgrave, "Manufacture and Industrial Application of Flexible Tubing."

March 30.—Ewing Matheson, "Foreign Exchange."

Papers, the dates of reading of which are not yet fixed:—

"The Fisheries Department: its Position and spects." By J. W. Willis Bund.

The Congo State." By Captain V. Lovett meron, R.N., C.B.

"Colour Blindness." By Captain W. de W. Abney, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. Addenbrooke.

"Egyptian Agriculture." By Professor Robert Wallace.

Foreign and Colonial Section.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

March 15.—F. A. Pezet (Peruvian Consul General), "Peru: its Commerce and Resources." Clements R. Markham, C.B., F.R.S., will preside. 8 p.m.

April 5.—The Rev. John McLean, D.D. "Manitoba and the North-West Provinces of the Dominion."

April 26.—Sir Edward Braddon, K.C.M.G., "The Progress of Australasia." 8 p.m.

May 24.—Colonel Howard Vincent, C.B., M.P., "The Extension of Colonial Trade." 8 p.m.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

March 24.—G. H. M. Batten, formerly of the Bengal Civil Service, "The Opium Question." Sir John Strachey, G.C.S.I., C.I.E., will preside.

April 7.—Dr. J. Augustus Voelcker, "The Agricultural Needs of India."

April 28.—Sir William Wedderburn, Bart., "Reorganisation of Agricultural Credit in India."

May 19.—Jervoise Athelstane Baines, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir Charles Bernard, K.C.S.I., will preside.

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

March 29.—E. Roscoe Mullins, "The Decorative Uses of Sculpture." Alfred Gilbert, A.R.A., will preside.

April 12.—C. Purdon Clarke, C.I.E., "English Brocades and Figured Silks." The Lord Masham will preside.

May 17.—George J. Robinson, "Decorative Plaster Work" (II.). J. Hungerford Pollen will preside.

May 31.—William De Morgan, "Lustre Ware."

Cantor Lectures.

Monday evenings, at Eight o'clock:—

Prof. William Robinson, M.E., Assoc. M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

Lecture III.—March 14.—*Oil Gas.*—Gas generator and internal combustion engine *versus* steam-boiler and steam-engine.

Lecture IV.—March 21.—*Oil Fuel and Gaseous Fuel for Steam-boilers.*—Safe heavy oils available—Different methods of burning oils—Injector-burners—Evaporative power of oil fuel.—Advantages and disadvantages of liquid fuel on steamships—Transport and storage of petroleum—Other uses of petroleum for power purposes.

Bennett H. Brough, Assoc.R.S.M., F.G.S., "Mine Surveying." Three Lectures.

Lecture I.—March 28.—*Introductory.*—Nature of mineral deposits, and the modifications of the methods of surveying required in different mines—Accidents due to inaccurate surveying—Historical sketch—The oldest mine plan—The divining rod—The use of the magnetic needle in mapping deposits of iron ore.

Lecture II.—April 4.—*Surveying.*—The compass—Ancient forms of compass—Various forms of miner's dials and theodolites—Use of aluminium for mine-surveying instruments—Supply of light for reading the verniers underground.

Lecture III.—April 11.—*Levelling.*—The level and staff for underground use—Applications of levelling in mining operations—The Carrara marble railway—Aërial wire ropeways—Hydraulic mining ditches—The St. Gothard, Mont Cenis, and Croton aqueduct tunnels—The Ernst-August adit-level—Mapping bore-holes.

Dr. Percy Frankland, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.
May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. William Robinson, "The Uses of Petroleum in Prime Movers." (Lecture III.)

Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. 1. Report of Committee on Mr. Laing's paper, "Distillations of Mineral Oils. 2. Mr. John Whitelaw, "A Miner's Safety Cage or Hoist, and Safety Hoists generally." 3. Mr. Thomas Gillespie, "An Improved Safety Cage for Pits, Hoists, Lifts, &c., for the prevention of loss of life or injury to plant from Ropes Breaking or from Over-winding."

Surveyors, 12, Great George-street, S.W., 8 p.m, Discussion on the "Small Agricultural Holdings Bill."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. G. H. Garrett, "Sierra Leone and the Interior, to the Upper Waters of the Niger."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. Meymott Tidy, "Disinfectants, Gleanings from the Laboratory."

Tuesday, March 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. F. A. Pezet, "Peru: its Commerce and Resources."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture IX.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. John Glover, "Tonnage Statistics of the Decade 1880–90."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. H. Gadow, "The Classification of Birds." 2. Mr. C. Brunner v. Waltenwyl and Prof. J. Redtenbacher, "The Orthoptera of the Island of St. Vincent, West Indies." 3. Mr. Oldfield Thomas, "Some Mammals from Mount Dulit, North Borneo."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Wednesday, March 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Tempest Anderson, "Iceland."

Meteorological, 25, Great George-street, S.W., 7 p.m. Address by the President, Dr. C. Theodore Williams, "The Value of Meteorological Instruments in the selection of Health Resorts."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. E. M. Nelson, "Virtual Images and Initial Magnifying Power." 2. Mr. H. L. Brevoost. "Obervations on the Brownian Movement." 3. Dr. A. C. Mercer, "Lantern Demonstration on Photomicrographs and Photomicrographic Apparatus."

Archælogical Association, 32, Sackville-street, W., 8 p.m.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. A. S. Newman, "Shutters."

Civil and Mechanical Engineers, Westminster Palace Hotel, S.W., 7 p.m. Mr. A. Fairlie Bruce, "Water Work Fittings."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Thursday, March 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Allan P. Swan, "On the Vitality of the Spores of *Bacillus megaterium*." 2. Mr. Bertram Richardson, "Notes on the Zebras."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Dunstan, "The Conditions which determine Combination between the Cyanides of Zinc and Mercury and the Composition and Properties of the Resulting Double Salt." 2. Prof. Thorpe, "A Lecture Experiment, to Illustrate the Phenomena of Coal-Dust Explosions. 3. Dr. Armstrong and D[illegible] Kipping, "The Ketone Formed by the Action [illegible] Dehydrating Agents on Camphor." 4. Mr. [illegible] Pullinger, "Platinum Tetra-Chloride."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. A. Common, "The Chief Astronomical Laboratories of the World."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. P. Ker, "The Progress of Romance in the Middle Ages. (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 20, Hanover-square, W., 8½ p.m. Prof. W. Cunningham, "The Perversion of Economic History."

Numismatic, 22, Albemarle-street, W., 7 p.m.

North-East Coast Institute of Engineers and Shipbuilders, 8, Nicholas-buildings, Newcastle-on-Tyne, 7½ p.m. (Graduates' Section.) 1. "The Discussion on Mr. Oswald Wheeler's Paper, "Combustion of Coal." 2. Mr. J. Brentnall Duckitt, "Distribution of Electricity for Lighting Purposes."

Friday, March 18 ... United Service Inst., Whitehall-yard, 3 p.m. Mr. R. H. Scott, "Atlantic Weather and its connection with British Weather."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting 9 p.m. Mr. George DuMaurier, "Modern Satire in Black and White."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. Mr. H. M. Elder, "A Thermodynamic View of the Action of Light on Silver Chloride." 2. Prof. J. Perry, "On Choking Coils."

Saturday, March 19...Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Prof. T. E. Thorpe, "A Colliery Explosion."

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Matter: at Rest and in Motion." (Lecture VI.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, MARCH 18, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. William Robinson, M.E., Assoc. M.Inst.C.E., delivered the third lecture of his course on "The Uses of Petroleum in Prime Movers," on Monday evening, 14th inst.

The lectures will be printed in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1892 early in May next, and they therefore invite members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L. F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to Her Majesty the Queen.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 16th inst. Present:— The Attorney-General, M.P., Chairman of the Commission, in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., M.P., Major.-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, R. Brudenell Carter, F.R.C.S., B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Professor James Dewar, M.A., F.R.S., Major-Gen. J. F. D. Donnelly. C.B., Sir James N. Douglass, F.R.S., Sir Henry Doulton, James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B, D.C.L., F.R.S., Alexander B. W. Kennedy, F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., F.S.A., Sir Saul Samuel, K.C.M G., C.B., with Sir Henry Trueman Wood, M.A., as secretary.

ENGINEERING COMMITTEE.

The first meeting of the Committee on Engineering, Architecture, &c, was held on Monday, 14th inst. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., M.Inst.C.E. (Chairman of the Committee); William Anderson, D.C.L., F.R.S., M.Inst.C.E., Sir George H. Chubb, William Henry Corfield, M.A., M.D. Oxon., F.R.C.P., Sir James N. Douglass, F.R.S., M.Inst.C.E., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Charles Hawksley, M.Inst.C.E., William H. Massey, M.Inst.C.E., Reginald E. Middleton, Sir Robert Rawlinson, K.C.B., M.Inst.C.E., Colonel M. T. Sale, R.E., C.M.G., Captain Sir Henry W. Tyler, M.P., Professor W. Cawthorne Unwin, F.R.S., M.Inst.C.E., with Sir Henry Trueman Wood, Secretary to the Commission.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Intending exhibitors are reminded that applications for space must be made immediately, as the allotment of space will shortly commence. Most of the available space is now occupied, and no time should therefore be lost by manufacturers desiring to be represented.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

MEETING AT THE MANSION-HOUSE.

A meeting, promoted by the London Chamber of Commerce, was held on Friday afternoon, March 11th, at the Mansion-house, by kind permission of the Lord Mayor, to consider the British representation at the Chicago Exhibition.

There were present, among others :—The Lord Mayor in the chair; Sir Albert Rollit, M.P., Chairman of the London Chamber Commerce; Mr. Sheriff Foster. The following members of the Royal Commission: Sir George Birdwood, K.C.I.E., Major-General Sir Owen Tudor Burne, K.C.S.I., Mr. M. Carteighe, Mr. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., Sir Douglas Galton, K.C.B., Professor Roberts - Austen, C.B., F.R.S., and Sir Owen Roberts, with Sir Henry Trueman Wood, Secretary; also Prof. Grylls Adams, F.R.S., Mr. R. K. Causton, M.P., Prof. George Forbes, F.R.S., Professor Hughes, F.R.S., Mr. Hyde Clarke, Sir James A. Youl, K.C.M.G., Mr. G. N. Hooper, Mr. Hunter Donaldson, Mr. Kenric B. Murray (Secretary of the London Chamber of Commerce), Mr. Ex-Sheriff Walter Harris, Colonel Fitzgerald, and Mr. R. S. McCormick (Representative in Great Britain of the Chicago Executive).

The Lord Mayor, in opening the proceedings said he had been asked to take the chair at this meeting, the object of which was, he thought, of the utmost national importance, viz., to see what could be done to further in any way the movement for securing that Great Britain should be properly represented at the forthcoming Chicago Exhibition. The history of Chicago was quite unparalleled, and he had been particularly struck with some of the facts relating to it, narrated in the handbook of regulations and general information with regard to the Exhibition which had been prepared. A century ago Chicago was a pathless wilderness; in 1832 the first business building was erected by Mr. F. W. Peck, the father of one of the most prominent and wealthiest citizen families of Chicago of to-day. In the year 1833 the population had increased to 350, and in the same year the United States Government commenced the harbour works, which had since assumed such large proportions. It was worth noting that when there were but 350 inhabitants, there were four churches and four taverns, and the inhabitants then were somewhat ambitious, for in the year 1837 they succeeded in raising their town to the dignity of a city. In that year, when the first census was taken, the population had increased to 4,170, and thenceforward its growth was very rapid to the year 1871, when the great fire occurred which destroyed more than three square miles of buildings, and rendered 98,500 persons homeless, the total loss being estimated at nearly £40,000,000 sterling. The modern Chicago dated from that conflagration, and ten years afterwards all visible traces of the devastation had disappeared, and the new era of construction had commenced. The Chicago of to-day covered an area of 180 square miles, with a population of over 1,200,000; there were 2,200 miles of street railways, and over 2,000 acres of public works. Thirty-five distinct railways had accommodation in the city, and it was claimed that those railroads, with their branches and immediate connections, amounted to half the railroad mileage in the United States. The river was crossed by 61 bridges. Its most important thoroughfare, State-street, running north and south, was eighteen miles in length, or only three miles less than the distance between London and Windsor. The number of houses added to Chicago last year would, if placed side by side, give a solid frontage of fifty-one miles;

they numbered 11,640 structures, and cost nearly £10,000,000 sterling. This was a wonderful record of growth since the fire, and it was now intended to hold there one of the largest, most universal, and probably one of the most successful Exhibitions of modern days. It was, therefore, of immense importance to England that she should be well represented there. They would probably all agree that trade competition was never greater than at the present moment, and having regard to the keen rivalry of the Americans, Germans, and other nations, it certainly behoved this country to be thoroughly well represented, so that it might go forth to the world, and to the millions who would visit this Exhibition, that we were not behind our neighbours, but that the England of old was the England of to-day. All European countries were giving their Commissions substantial grants, and although the Government of this country was not giving as large a grant as he should like to see, still it was supporting the Commission by a grant of £25,000. There was scarcely a movement of any importance which had not difficulties connected with it; and the great difficulty, in this instance, was the McKinley tariff. That certainly did not ease the way; but it, of course, only applied to America itself; and, inasmuch as the visitors would come from all parts of the globe, it was worth consideration, by the manufacturers of this country, whether it would not be well worth their while to send forward their exhibits, with a view to retaining and enlarging the number of their customers all over the globe. He could only urge that they would give this matter full consideration, so that we should not be behind others in placing our products in a favourable position.

Sir HENRY TRUEMAN WOOD said there were several members of the Royal Commission present who could speak with greater force on the general subject than he could, but there a few points with which his official work had, perhaps, rendered him more familiar, to which he was glad to have the opportunity of referring. First of all, he might say that a sufficient number of representative firms had sent in their names to the Royal Commission to make it quite certain that this country would be not inadequately represented, and further that, considering not only the exhibits from the mother country, but those coming from the various colonies and from India, the British Empire would be as well represented as it had ever been at any previous Exhibition. He would first mention the great difficulties in the way of exhibitors, and then show that they were not quite so great as might appear in the first instance. The Lord Mayor had alluded to the greatest in the McKinley tariff. The second was the great distance and consequent cost of exhibiting; and the third the special expenditure necessary for exhibitors in consequence of the whole expense not being defrayed by the Government grant. The McKinley tariff was, after all, not such a very large increase on the Customs' duties which had been maintained in America for many years; no doubt it was an increase, but it was not as if America had been a free trade country which had suddenly become protectionist. Then the tariff only affected half of the imports into the States, and with regard to one-half of the remainder, or one-fourth of the whole, it could have practically but small effect, because the goods therein comprised could not be made in the United States at all, and if they were to be consumed there they must be imported. It was by no means certain either that this tariff would be permanent. At the last congressional election the people declared very strongly against it, and it might consequently be very soon either abrogated or modified. It would be a matter of small importance that the tariff should be in existence during the Exhibition, if it came to an end immediately afterwards. The statistics, so far as they were available, showed a falling off in British exports during the past year, but it was almost as marked in the exports to other countries as to America. This went to show that a very small proportion of this loss was due to the tariff. The fact that the depression of trade now complained of was not due entirely to the tariff was shown by the example of two of the largest textile manufacturers, of whom one firm started a manufactory in the States, thinking that they could profitably manufacture their goods which they could not profitably export there; but they found it impossible; whilst the second firm, of equally high standing, having made inquiries, with the object of doing the same, found it would be impracticable, and abandoned the idea of setting up an American factory. As this point would be dealt with by Mr. McCormick, the representative of the American Executive, he would pass on to the other two points. First of all with regard to the distance; no doubt it involved a journey of 3,000 miles by water, and 1,000 miles by land, but this was minimised by the fact that the Royal Commission had obtained special and considerably diminished rates of freight, both by land and sea, and the American railways would also make a considerable reduction in their charges. No doubt the work of the Royal Commission would have been easier if they had had larger funds at their disposal. They could only say that they had this amount to administer, and would do so to the best of their ability, but the meeting should understand that it was an absolute necessity that additional charges should be made on the exhibitors if the country were to be adequately represented. All experience showed that £25,000, however economically expended, was not sufficient to defray the legitimate expenses of a section at a foreign Exhibition. Additional funds must come from somewhere, and there was no other source except the exhibitors —those who made special profits by exhibiting. The Commission administering a Foreign Section had not only to look after the interest of the ex-

hibitors—although that was their first and greatest duty—but also to see that the country was adequately represented in many departments for which funds were not forthcoming. He need only mention fine arts, and educational and scientific exhibits amongst others, all of which involved certain legitimate expenditure, which could not be met from the amount of the grant. In conclusion, he could endorse very strongly his Lordship's observations that English manufacturers must remember that the competition of other countries was becoming, day by day, more intense, that those other countries were fully awake to the importance of taking away our trade, and that it was our bounden duty to use all the means in our power to prevent them succeeding. The Americans themselves looked on this Exhibition as a magnificent opportunity for robbing us of our South American trade, and they were doing their best, quite legitimately from their point of view, to take it away from us, and we must do our best to prevent them. The Germans were vyeing with the Americans in the same direction. Other countries were doing the same; even our own colonies were more ready to see the advantage of exhibiting than our people at home; and it was our bounden duty to struggle to the utmost not to lose such a magnificent opportunity for advertising English industries in the presence of the great American public, and that vast crowd of exhibitors from all parts of the world who would be certain to congregate next year at Chicago.

Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., said he ought to apologise for speaking at all, for he was an Exhibition man of the past, and they were considering an Exhibition of the future. Still there was some of the old spirit left in him yet. He did not like the idea of England being beaten by the Americans or any-one else. He was quite sure we had only to show what we could do, and we should carry the world with us. He hoped people would not be frightened at the McKinley tariff, which was held up as a bugbear. He believed that before the Exhibition was half over the tariff would be torn to pieces, because the American people would insist on having their goods at proper prices. They learned some of the real prices of goods on their visits to this country; but when they saw the prices marked on the goods in the Exhibition, they would insist on having the goods at the proper prices from the old country which had served them so well. They would know that goods sent from here were genuine and of sterling quality—which they could depend upon. He appealed to all gentlemen present to support the London Chamber of Commerce in making this Exhibition such a one as could be looked upon with pleasure and pride. He took it this was the final effort, and we were bound to show our relatives in America that we were still alive, and were not going to be superseded by any other nation. He knew how pushing foreigners were, and that they would push us out of the market if we would allow it, but if we did, it would be our own fault. He had had some experience of foreign nations, and knew what British manufacturers could do, and he was proud to say that England always came out first. He was certain that South Americans and others would much prefer going to English manufacturers where they would be certain the goods were what they were represented, rather than to the manufacturers of any other nation.

Mr. R. MCCORMICK said it gave him great pleasure, immediately after his arrival from Chicago, to be able to report progress at the seat of war—he might call it—the war of friendly commercial rivalry, in which he hoped Great Britain would take a leading part, such a part, that not only Old England, but New England, would have reason to be proud. The buildings were progressing satisfactorily. It was said that Americans treated women with the greatest possible consideration, and as evidence of that, he might say that the women's building was the first to be completed, and only now required to receive the decorations, which were sure to be successful. Reference had been made to the effect of the McKinley tariff on the trade with America; most present knew probably, though they might have forgotten it, that the Americans were far away England's best customers, for in the first nine months of last year, during the operations of the McKinley tariff, there were over £21,000,000 sterling in manufactured articles sent to America, whilst Germany, the next best customer, took about £14,000,000. That was a trade which England could well afford to cultivate. There was one important fact which would make it necessary for a long time for America to take a large amount of manufactured goods from England. There was an enormous work to do in the construction of new lines of railway, the making of new canals, and the development of internal commerce, which would take a large number of working men, to clothe whom they must purchase from abroad. England had always furnished America with large quantities of woollen and cotton goods. Some idea of the amount of internal commerce might be drawn from these figures. In 1890 the tonnage of vessels proceeding through the Detroit River was 21,000,000 tons—more than three and a half times that passing through the Suez Canal. The tonnage of vessels arriving at and departing from Chicago was 8,000,000.* These figures gave some idea what the consumption of foreign goods must be. Then it must be remembered that America had to send to Europe a large proportion of bread stuffs and meat products, and as long as that continued she must largely take manufactured articles in return. It would be long before she would be able to consume the whole of these produts herself, and during that time England must be a large exporter

* The tonnage of vessels arriving at and departing from Liverpool was 11,000,000 in round numbers.

to the States. All these exports and imports too were carried under the British flag in British bottoms. In that trade America was not now a competitor, though he hoped she soon would be. They intended to leave no stone unturned to gain what they thought their share of the trade with South America. She was a neighbour, and they proposed to enter into a friendly contest with England to get that trade if they could; they would try to undersell the old country and would be able to supply quite as good a quality of goods. He might also say that what America knew about tariffs she had learnt from England. It was only a few years ago that England abolished her tariff, and that was when she felt herself strong enough to throw down the gauntlet to the world. It was like a merchant who had accumulated a large amount of capital and then said, "I can undersell you, no matter what other advantages you have." America had never gone so far as England had in protecting her woollen trade. She had never placed an embargo on the export of cotton, which might have been done if there was anything hostile in the passage of a Tariff Act; but had allowed England to take American cotton, manufacture it, and send it back again, paying the freight on it both ways to English carriers. He hoped that, when he returned to Chicago, at the opening of the Exhibition, he should be able to feel proud, not only of the exhibits of his own country, but equally proud of those furnished by Great Britain, and to congratulate his friends of the Royal Commission on the good work he was sure they would accomplish.

Sir DOUGLAS GALTON, K.C.B., said he attended on behalf of the Council of the Society of Arts, who had undertaken, at the request of the Government, to act as a Royal Commission for promoting this Exhibition, and he hoped that, with the assistance of the Lord Mayor and the London Chamber of Commerce, they would be able to do so effectively. The a[illegible]ges of exhibiting in Chicago had been so full[illegible]ward by previous speakers, that he could r[illegible]ch on that point, but he might say that [illegible]he advantage of visiting America on ma[illegible]nd was present at the Philadelphia E[illegible]which the American manufacturers r[illegible]glish competitors very close indeed, esp[illegible] machinery. He thought, therefore, it wou[illegible]e a great misfortune for this country if her mac[illegible]nists did not take part in this Exhibition. He believed they would have an opportunity there, which was not allowed at Philadelphia, of stating on the exhibits what the price would be apart from the duty. If this were allowed, it could hardly fail to strike a serious blow at the McKinley tariff. He trusted, therefore, that British manufacturers would make a good appearance at Chicago in competition with their American cousins.

Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., said he could really add nothing to what had been so ably stated by the Lord Mayor and others as to the forthcoming Chicago Exposition, but he, as one of the Royal Commissioners, hoped all present would take to heart what had been said, and that there would be a good British exhibit. They all knew that the colonies were making great efforts to take a prominent part in the Exposition, and he had reason to believe that India also would come out strongly on this occasion; he hoped, therefore, the mother country would not be behindhand. The Royal Commission was very anxious to give information or assistance in any possible way, through its secretary, Sir Henry Trueman Wood, who had already taken so much trouble in the matter. He enjoined all to put their shoulders to the wheel, so as not to be left behindhand by the Colonies and India, but rather to bring out Old England in the position she ought to occupy, especially as this might be her last struggle to maintain her pre-emience in the commerce of the world.

Sir A. K. ROLLIT, M.P., then moved:—"That the best thanks of the Chamber of Commerce and of this meeting be given to the Right Hon. the Lord Mayor for presiding, and for permitting this meeting to be held in the Mansion-house." When the Chamber of Commerce, doing as it thought its duty to the commerce of London, asked the Lord Mayor to allow the meeting to take place there, the proposal was readily entertained, and every possible facility given; and he might mention as showing how busy the life of a Lord Mayor was that that was the second time that day he had proposed a vote of thanks to him in that room. That morning his Lordship had received the Municipal Corporations, and that afternoon the representatives of commerce; and he did so in the same admirable way as that in which he took part in all movements of a good character. They owed him very much for his introductory speech. John Bright once said that not a boy in a day school could take a map and put his finger on Chicago. The Lord Mayor had certainly shown himself possessed of a great deal of knowledge about it; and that information was now shared by all. There was no doubt that this movement was for the welfare of the country, and was brought forward on that broad basis, that competition had to be met. Without following all that had been said by Sir Philip Cunliffe-Owen, he might remind them of what an equally great man—Voltaire—had said, that England rules the waves, France the land, and Germany the clouds. England still ruled the sea, and hoped to continue to rule it commercially, notwithstanding the efforts of their American friends. The ruling of the land might be a debatable question, but Germany certainly did not merely rule the clouds. She had come down from the clouds, and we had to meet her competition on the land. But Germany had the wisdom, a century before we began to learn it, to

see the necessity of education. It was to that she owed her present position, and we should take care that our people had similar advantages, and that they were placed abreast of the times in getting that knowledge which was the very condition of profit, a knowledge of saving, and of the methods of lessening the costs of production. That could be done no better than at these Exhibitions, and it would be a great lesson to our countrymen if they took part in it. There was a great deal of justifiable feeling about the McKinley tariff, but there was a hope that it would not be permanent. One of the speakers had bidden them go to their relations, and it could not be supposed that those relations would close the door in their faces. It would have to be opened. He never met an American woman who did not hate the McKinley tariff. They must have their costumes imported, and they hated having to pay the duty, so that in the days when women got votes there would be a powerful influence brought to bear on this question, and he trusted that would be an indication of better times and improved commercial relations. Already some concessions had been made which should be appreciated. He had reason to believe that the real true price at which articles could be obtained in England, irrespective of duty, would be allowed to be marked upon them, which would be certainly a benefit to the exhibitors of this country. It would prevent any misapprehension, and might illustrate certain economical principles for the benefit of America. The Chamber of Commerce were taking steps to establish an Intelligence Department in the grounds of the Exhibition, so that the full benefit of English enterprise in that direction might be reaped by those who took the trouble and incurred some expense in exhibiting. He had been asked to mention that the official date for applications to exhibit had passed, but there was still some space left, although it was rapidly being occnpied, so that early application was necessary.

Mr. Sheriff FOSTER, in seconding the motion, said they were all under a debt of gratitude to the Lord Mayor for the useful information he had contributed. They had been told that the McKinley tariff would be a great obstacle to the success of this Exhibition, but he ventured to think that its importance had been to a great extent removed. Even if it were to continue, this being a World's Fair, the exhibitors might hope to find customers from all the world, even if the United States were partially closed to them. Mr. McCormick had told them that the United States intended to try for the South American trade, and that alone was worth struggling for. But they might hope that the citizens of the United States would not be so foolish as to continue to allow themselves to be taxed in this way. He was present at Philadelphia, in 1876; and even his inexperienced eye was attracted by the Engineering Section, to which Sir Douglas Galton had referred; nd it was quite evident that English engineers would have to do their best in order to maintain their position.

The vote of thanks having been carried by acclamation,

The LORD MAYOR briefly responded, and the proceedings terminated.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 15, 1892: CLEMENTS R. MARKHAM, C.B., F.R.S., in the chair. The paper read was "Peru: its Commerce and Resources," by F. A. PEZET.

The paper and discussion will be printed in next week's *Journal.*

FOURTEENTH ORDINARY MEETING.

Wednesday, March 16, 1892; Professor CLEMENT LE NEVE FOSTER, D.Sc., in the chair.

The following candidates were proposed fo[illegible] election as members of the Society:—

Corderoy, George, 19, Queen Anne's-gate, S.W.
Cowper, Joseph, Penrith.
Crossley, Arthur W., Bentcliffe-house, Accrington.
Lloyd, Edmund H., Selhurst, 8, The Avenue, Ealing, W.
Ravershaw, Henry Willock, 32, Albany-road, Ealing Dene, W.
Rotch, A. Lawrence, Readville, Massachusetts, U.S.A.
Toop, Robert, Trent-villa, [illegible]on-road, Bournemouth.
Walker, Theodore, Glen-[illegible]eicester.
Wates, Edward A., Lon[illegible]an, India.

The following ca[illegible]e balloted for and duly elected m[illegible] Society:—

Gough, Kedgwin E. K., [illegible]n-road, Brixton, S.W., and Board of Trade, [illegible].
Grant, William, University C[illegible]ege, Gower-street, W.C.
Kapp, Gisbert, 31, Parliament-street, S.W.
Legard, Colonel James D., 13, The Cliff, Scarborough.
MacLean, Robert Black, Woodville, Burghill-road, Sydenham, S.E.
Scorgie, James, Poona-villa, King's-gate, Aberdeen.
Scott, Ernest, 3, Investment-buildings, 67, Lord-street, Liverpool.

The paper read was—

ICELAND.

By Tempest Anderson, M.D., B.Sc.

The author visited Iceland in the summer of 1890, with the especial object of examining and photographing the volcanic phenomena with which the country abounds. When, therefore, he was asked by your Secretary to exhibit his photographs before your Society, he proposed, as a title, "The Icelandic Volcanoes;" but on its being pointed out that the Society of Arts does not deal with questions of abstract science, but only with its applications to the useful arts, and that volcanoes are chiefly destructive in their effects on man and his works, he agreed, with some misgivings, to say more on the material and social condition of Iceland and its inhabitants, and less on the main objects of his visit to that country.

Iceland is an island about the size of Ireland, situated just outside the Arctic circle. The inhabited, or habitable, portion is confined to a narrow belt round the shore, the centre portion being occupied by volcanic mountains, lava extensive deserts, sandy [illegible]s, and snow mountains mostly flat-[illegible]ed, called "Jokuls." The interior is [illegible]ersed by a few desert tracks, seldom [illegible]sed, and becoming less so since the establishment of a regular service of steamers round the north coast. The north coast is much broken up into promontories and fjords, or deep bays, at the ends of which most of the villages—they scarcely deserve the name of towns—are situated. The south coast, on the contrary, does not boast a single harbour where a steamer can lie in safety, between Reykjavik and Hafnafjord on the west, and Berufjord on the east, for, though it is true that the small trading station of Eyra Bakki is situated here, and small sailing vessels find some shelter from the Atlantic swell behind a reef of rocks, the entrance is narrow and dangerous for any ordinary craft in which a landsman would like to trust himself. Add to this, that many large rivers, quite disproportionate to the size of the island, come from the desert interior and here flow into the sea; that they are mostly broad, swift, and icy cold, and often with quicksands in their bottoms; and we see at once the reason that this part of the island is seldom visited by travellers, and that the inhabitants enjoy fewer of the necessities, to say nothing of the luxuries, of life than in other parts. Yet in this part are situated the great volcanos of Kotlugiâ and Skapta Jokul, which it was the author's object to explore on his visit to the island in 1890.

Iceland can be reached in about four or five days by steamer from Leith, at intervals of about a fortnight or a month. The Danish mail steamers run about once a month, and at any rate one of them, the *Laura*, has the reputation of being an excellent boat. They call at the Faroe Islands, thereby making the passage extend to seven days instead of five, and are sometimes behind time, but can be depended on eventually to arrive at their destination. The Scotch boats run nominally once a fortnight during the season, but really only if sufficient cargo offers, and hence cannot be depended on for a return passage, as the author knows to his cost. Two of them have been lost during the last few years.

Arriving at Reykjavik, we find ourselves in the capital of Iceland, a straggling village or small town of 2,500 inhabitants. The chief buildings are the Governor's house, a plain whitewashed building apparently of about a dozen small rooms, a church or cathedral, also whitewashed, capable of holding probably 400 people, and the Parliament-house, a building of very moderate dimensions, yet accommodating a free library on the ground floor, the Parliament chamber on the first floor, and the national museum in the attics. The Latin school, and one or two elementary schools, complete the sum of the public buildings, except the gaol, which has twelve cells generally empty. Long may it continue so.

There are several stores where may be bought a motley assortment of goods from a needle to a chain cable, and from paraffin to tinned meats, and Manchester goods. The houses are nearly all of wood or galvanized iron, for though there is plenty of stone and materials for making the best cement in the island, there is no fuel to burn it or lime. Dried fish is the staple commodity of the place. It can be seen spread out to dry on the rocks, the beach, and the streets, whenever the weather is favourable.

The climate is not as severe as might be expected from the latitude—just outside the Arctic circle. The island being situated in the Atlantic in the western prolongation of the Gulf stream, does not suffer from such extreme cold as the adjacent coast of Greenland. As far as I could gather, the windward side of the island is generally covered with clouds and mist, owing to the moisture being condensed from the comparatively warm sea air by contact

with the cold mountains of the interior, while the air, thus deprived of its moisture, passes forwards, and the lee side is comparatively dry and clear. As the wind was south-west during the greater part of June and July, 1890, the author, in the south-west of the island, had ample opportunities of verifying the truth of this statement. It is most tantalising to ride for days together in a cold drizzle under the cloud-cap, while in the distance, to windward, it constantly looks as if the weather were clearing up, the fact really being that the air at that distance has not yet felt the influence of the cold land, and its moisture is still in solution.

[Photographs illustrating these appearances were shown on the screen.]

The northern part of the island has the reputation of being drier than the south, a fact amply accounted for by the prevalence of the south-west winds. On the other hand, to some extent every spring, but to a serious extent at intervals of a few years, large masses of polar ice occasionally drift down on the north coast, and that district then comes in for its share of cold, wet, and mist. In a bad "ice year" the hay—the only harvest—does not ripen; the sheep and ponies die in large numbers, or have to be killed, and the natives are threatened with starvation.

The first requisite to a traveller in Iceland is a guide and ponies. As to the former Thorda Zoega had been written to in advance, and he proved a very obliging and trustworthy man. The Icelandic ponies are a similar breed to the Shetland ponies. They are very hardy little beasts, never taste corn, live on fresh grass in the summer, and a little hay and a few dried codfish heads in the winter, and as even these are often scarce they are often very weak and in poor condition in the spring, a reason against visiting the island before June or July. It is usual to have two ponies to each load, animate, or inanimate, one being loaded in the morning the other in the afternoon. The spare ponies run along unloaded, and in this way they will travel long distances of 40 or 50 miles a day for days in succession, provided the pace is varied, first walking, then trotting a few hundred yards, then a short gallop, then walking again, with occasional rests. They run well in company. Out of fifteen or twenty one or two will soon be recognised as the leaders, and the rest will follow these, but no amount of whipping will persuade them to go even a short distance separately, a fact which the traveller soon finds very inconvenient if his pony does not happen to be a leader, and he is yet anxious to deviate occasionally to examine objects of interest off the track. This inability to run except in company has gained the Icelandic ponies a character for stupidity in this country, where they are seldom used except in the coal mines. For this purpose several cargoes of 300 or 400 each are exported yearly to Newcastle. The Icelanders do not understand breeding ponies, and hence make no effort at selecting the best to breed from, a fact which much diminishes their possible value as an article of trade.

The traveller will be astonished at the number of ponies necessary to transport himself, his guides, and the most moderate amount of luggage. Each pony will only carry a pair of wood boxes, each as large as a small Gladstone bag, and where, besides the personal luggage, photographic plates, provisions, and a tent have to be carried, this requires at least three pack horses, or six including the relays. Two travellers and the guide, at two a-piece, makes six more, or twelve in all; and twelve horses require two men or boys to prevent them straying at night, each of whom require two horses, making sixteen, or, with a spar[illegible] horse, seventeen, which was the number ta[illegible] It is needless to say that this renders travel[illegible] in Iceland more expensive than in any ot[illegible] European country.

It is interesting to note that on returning to York with the baggage as above, one of the saddles, and a large collection of stones which had been accumulated in three batches at Reykjavik, the writer naturally was going to take two one-horse cabs, but the first cabman volunteered that he could take it all, including the two travellers, very well on one; a proof, if one were needed, of the advantage effected by the use of wheeled conveyances and good roads.

The most useful provisions to take are tinned meats, biscuits, a few raisins, and tea, or, still better, chocolate. Coffee can always be obtained, even at the worst farms, and is generally excellent, but owing to the want of fuel, the traveller arriving after riding all day in the wet, will often have to wait two hours before he can get anything to eat or drink. Hence it is advisable to take some form of portable apparatus capable of quickly boiling a pint or two of water, and, if posible, it should burn paraffin, which can be got in most places.

Except in Reykjavik, and possibly one or two other towns, there are no hotels or inns of any kind, and the traveller must either live in

his tent or lodge at the farmhouses, where it is only fair to say he will almost universally be received most hospitably and provided with the best, such as it is, that the place affords.

The Icelander is under great disadvantages in the construction of his house. If he has lime he has no fuel to burn it, he has no wood except that cast on the shore by the Gulf Stream, which provides him with a few worm-eaten pine trees and a very occasional balk of mahogany which has broken astray from a raft in some South American river, or been washed off a ship's deck in a storm. He has no straw for thatch, no slates or tiles, or fuel to burn them, no glass, except that carried on horse-back for great distances over vile bridle roads and well nigh impassable rivers. The house is therefore built of rough blocks of lava, bedded in turf, to form walls about six feet thick, and banked up with earth on three sides. The roof boasts a few wooden rafters, but is mainly composed of birch bark covered with a thick layer of earth and sods. The best grass of the farm is that cut from its roof. The front of the house is usually built in gables of stone and turf at the bottom and wood above, with a few small windows. These sometimes open, often [illegible] in which case there will occasionally be one or two holes in the frames about an inch in diameter, closed by plugs which can be removed when it is desired to admit a little air.

The Icelander has no coal or wood, and very little peat for fuel, and must content himself with a little turf or dried horse dung. If he uses turf, it is years before it grows again; and often, in the meantime, the wind gets hold of the volcanic sand so laid bare, and spreads it over, and so ruins the adjacent pastures. In the result, he must build a house with no fireplace except in the kitchen, and with rooms so small that the inmates keep each other warm by overcrowding. The chief room is used as the sitting-room by day and the bed-room by night, and is occupied by the farmer, his wife and family, the servants, male and female, in all often more than 20 or 30 persons. It is provided with no fire or stove, but with beds all round, sometimes two stories high, like the berths of a ship. The lower row serve as seats in the day. There are often, perhaps generally, no chairs, except one or two in the guest-room, which is kept for strangers, and only used by the family on ceremonial occasions.

What wonder that people, living in such conditions, in a vile, damp, cold climate, suffer from chronic bronchitis and rheumatism; that leprosy is far from uncommon, and that tape-worm, echinococcus cysts, and other parasites abound. The guest-room is generally about 10 feet by 7 feet; sometimes a little larger. It is lined with wood, and has several wood pegs, on which hang the spare garments of the family; several chests, which contain family treasures, and serve as seats; sometimes a chair or two, generally, a small table. The bed is often built into a recess in the wall. If the traveller is induced, by stress of weather, to attempt to use it, he often finds it already occupied, and is often kept awake by the constant coughing in the next room; for every Icelander has a cough.

The inhabitants, though of the same stock as the Norwegians and the Yorkshiremen of England, both tall races, are mostly stunted by generations of hardship. Like most inhabitants of out-of-the-way places, they are almost without exception, hospitable, obliging, and honest in their dealings with strangers. The men wear short, double-breasted coats of home-spun cloth, generally dark coloured, and when travelling, long boots, reaching well up above the knees. These are for fording the numerous rivers. At other times, they wear a sort of moccassin of untanned sheepskin. It is made in one piece, the corners being brought up, and fastened in some way over the instep. The women wear, usually, little distinctive of their nationality, except a cap with a tassel, said to be a survival of the old Phrygian cap. Some of them still possess jackets and skirts, ornamented with silver embroidery, and belts of filigree silver of fine workmanship. These are now getting scarce, but specimens may be seen in the Museum at Reykjavik.

With all the above described material difficulties to contend with, it is not surprising that many of the Icelanders have emigrated to America, but I was confidently assured that many of these emigrants would be glad to be back. The Icelandic farmer is not accustomed to hard manual work. His house was built generations ago, and receives, I will not say requires, little repairs. He has no ploughing to do, no harvesting except the little hay, he seldom walks about his farm, but almost always rides, and thus, though perhaps often short of food, contrives to exist. When he sells his belongings and emigrates, he realises, I was told, perhaps £50, most of which is spent by the time he arrives at his destination, and he then has no horse to ride, no ancestral house, and no means of living except by manual work, in which he has to compete with

English and Irish labourers accustomed to do half as much more in the same time, though possibly not for such long hours.

In the more remote parts, such as the Skaptadalr, many articles of bone and stone are still in use, which, in more accessible districts, have been replaced by metal or earthenware. A photograph exhibited shows a wheelbarrow with a stone wheel, a steelyard with a stone weight, a hammer with a stone head, and a net with bone sinkers. At the same farm a quern, or stone hand mill, was in use, also horn stirrups, and harness fastenings of bone instead of metal buckles, to say nothing of bone pins and rude bone dice. At a neighbouring farm was a basin formed of the cup joint of a basalt pillar. Truly we still have a survival of the stone age. Less remote than this is the meeting place of the County Council of the district, consisting of a spacious cave in the lava. It would be difficult to find anything more appropriate to such a primitive land.

The roads, such as they are, are merely bridle tracks. Where they traverse stony moors and lava streams, they are mended by taking off the largest stones, leaving the smaller to tread down; where they cross bogs they are occasionally carried on artificial embankments. Bridges are almost unknown. In the few cases where new roads have been made, they have evidently been laid out by unskilled persons, and the work has often been begun in the middle; then, before the road has been finished, the plan has been changed, and the whole abandoned. I saw several large pieces of road out in the wilds leading nowhere, and which will never be used. It is only fair to say, however, that near Reykjavik there is about twenty miles of new road beautifully engineered by men who have recently returned from learning road-making in Norway. Even in these roads, however, there are gaps left unmade at intervals. This, I was told (let us hope falsely), is to prevent people spoiling them by using wheeled carriages or carts on them.

The numerous hot springs constitute one of the chief wonders of Iceland. They are very numerous, and as various in their volume as in the composition of their waters and the products deposited from them. The great Geyser, which has been so often described, spouts its mighty volume of water, only slightly charged with silica, and deposits a silicious sinter called geyserite; and several other springs, such as at Reykjanæs, deposit similar formations; others are so charged with ferruginous and sulphurous mud, that they appear like boiling cauldrons of red and blue paint. Some of the Reykjanæs springs, and many of those at Krisuvik, are of this kind, as are the more celebrated mud geysers of Krabla, in the north of the island.

At Krisuvik, and some other places, besides but connected with the springs, are fumaroles, from which some sulphurous vapour and steam escapes. This has given rise to deposits, more or less extensive, of sulphurous earth or mud, on the top of which a crust forms on which it is possible to walk; care is, however, necessary, for if the traveller should happen to go through the crust, he will be precipitated into a mass of boiling sulphurous mud. It has been proposed to work these deposits for shipment to England, and a company was formed, which came to an untimely end. We visited the house built for the manager at the springs; it was built of galvanised iron. Could any one have conceived a material less likely to resist sulphur fumes? There were many difficulties which operated to prevent success. The natural idea would have been to burn the crude sulphur in *calcaroni*, or kilns, like those used in Sicil[illegible] The heat produced by the burning of [illegible] of the sulphur melts the remainder, and it [illegible] out in a refined state into moulds. Bu[illegible] Sicily the deposit is dry—here it was liqu[illegible] mud; there was no means of drying it. Krisuvik is near the sea, and this was conspicuously marked on the map published at the time; but the coast is rocky, and there is no landing-place. In reality, the sulphur had to be carried on ponies for many miles over the mountains to Hafnafjordr. We were told that about seventy horses died one year, and the attempt was then abandoned. No wonder the venture was unprofitable to the shareholders.

The rivers of Iceland are large, and out of all proportion to the island, and are especially large and dangerous in the southern part, as it is here that most of the great rivers draining the desert interior of the island, and especially the glacier streams proceeding from the Myrdals, Skaptar, and Vatna Jokuls discharge themselves into the sea. They constitute, in this district at any rate, a most serious hindrance, and occasionally a positive danger to the traveller. Most of the worst are broad and swift, rather than very deep, a common size being a quarter of a mile or more wide, the depth in the fordable parts perhaps four feet, and the rapidity sufficient to make the icy cold water surge and foam up against the

traveller's saddle and water boots. It is no wonder that a stream of these dimensions, flowing over a sandy and gravelly bottom, constantly shifts its course, and that quicksands are common. A place may be safely fordable to-day, and deep water next week. Hence the necessity of always taking a local guide from the nearest farm. Where the river comes from a lake, the water will be pretty clear, so that the bottom is partly visible; but if from a glacier, it will be loaded with mud, which prevents a view of the bottom, and this, with its icy coldness, adds greatly to the difficulty and danger of the crossing. Deaths occur not infrequently from horse and rider being carried away. Sometimes a river spreads itself out into many parallel arms, and the guide in search of a ford seeks by preference such a part. If the river is not fordable at present he must seek a ferry at a narrow part where the banks are good. This is always a tedious undertaking. First the ferryman must be found, which is sometimes difficult even if he lives on the near side of the river, but the difficulty is much worse if both he and the boat are on the opposite. Then all the horses are unsaddled, and the saddles, pack boxes, and gear are put into the rickety boat, and the horses, with much shouting and cracking of whips, are driven unwillingly into the stream. As soon as they are well swimming, and too far out to turn back, the travellers and guides hurry across in the boat as quickly as possible. By the time they are across the horses have all landed, and, feeling cold, have started off at a canter. A guide runs after them, and with some trouble catches one, which he mounts, and pursues the others, and eventually drives them all back to the ferry. Then the whole cavalcade has to be resaddled, and the packs adjusted, so that, before the caravan is fairly on its way again, at least an hour, but often more, has been wasted. What wonder that the guide always prefers to ford if possible.

The main object of our visit was to examine the great volcanos of Kotugiá and the Skaptá Jokul, the former of which appears not to have been visited this century, while the crater of the latter had, we were assured, never been reached since its formation in 1783.

The crater of Kotlugiá is a vast fissure situated high up among the glaciers of the Myrdals Jokul, and is now so filled with snow and ice that our distant view of it did not promise much from a nearer inspection. Moreover, the weather being abominable, and the snow in bad condition, we were reluctantly compelled to abandon the attempt. One peculiarity of the eruptions arises from its position under a glacier or snowfield, viz,, that when the incandescent gases and lava escape, the snow and ice are suddenly melted, and a vast outpouring takes place of mingled boiling water, ice, volcanic mud, pumice stones, and ashes. This rushes with great velocity to the sea, devastating everything. We rode across a plain about twenty miles wide, which marks the track. The last eruption took place in 1866. Scarcely a blade of any kind of vegetation has yet begun to appear on all this vast area. Certainly the volcano deserves its name of Kotugiá, the Kettle crater.

The second main object of our journey was to explore the lava fields of the Skaptá Jokul, mentioned in all the books on vulcanology as being among the largest known. The great eruption of this volcano in 1783 is well described by Lord Dufferin in his "Letters from High Latitudes," and especially by Henderson, a missionary who visited the island in 1814, when the facts were fresh in living memory. Two great streams of lava issued from the desert interior of the island, one descending the valley of the Skaptá river, and another, that of the Hervisflot, the first being about fifty miles long, and the latter perhaps forty. Both appear to have issued from the same great fissure, on which a line of craters has been thrown up. We determined to endeavour to reach the craters by the former valley. We slept at the last farm in the valley, and were fortunate in obtaining the old farmer as guide. He at once told us that, though he had taken several parties of travellers far up the course of the lava, none had ever reached the crater; but he was quite willing to make the attempt. We therefore started next morning, keeping at first some distance from and then close alongside the lava. At last we found it necessary, in order to get to a set of cinder heaps which promised a passable road, to cross the main stream, and had some difficulty in getting our clever little nags across; but perseverance prevailed, and going further on, we encamped in the evening at the last patch of grass at the edge of the desert. Next morning, after a hard, frosty night, the weather proved good, in fact, the only good day for many days, and by riding as far as possible into the desert, and then leaving the horses and going forward on foot, the craters, the objects of such a long journey, were at last reached. They extend in a line for several

miles along a great fissure, which is still, in many places, clearly visible. At the lower end are two or three dwarf craters, then the two or three main orifices, from which most of the lava has poured out in billows of fire, now solid and black, it is true, but retaining their shape perfectly; and, further on, several others from which the gases and steam evidently chiefly escaped.

The higher craters, from which the steam and vapours escaped, are roundish or oval; and the fissure can still be seen along their bottoms in places, of a width of several feet. Traces of it are also visible going under the heaps of scoriæ which separate adjacent craters, and here constitute their walls. The outer slopes of the craters are gentle, the inner often nearly precipitous, this conformation being apparently due to the scoriæ having been ejected in a pasty condition, so that they stuck where they fell; and thus, while those which fell again directly into the fissure would be blown out again, those which fell out of the direct line attached themselves, and did not roll back, to fill up the vent, as we so often see in ash cones. These craters also illustrate most strikingly the fact that water, except as running streams, has scarcely any eroding power. Though they have been erupted over 100 years, their edges are as sharp and perfect as the day they were formed, the explanation being that the scoriæ are so porous, that the rain as it falls, and the snow as it melts, instantly soaks in, and never appears on the surface as a stream.

The lava near the craters is almost all of the corded or "*pahoheoe*" type, while, lower down the valley, immense fields of scoriaceous lava, or "*aa*," of the most bristling character are seen. The most probable explanation being that the lava, at the commencement of the eruption, contained much imprisoned steam and vapours, which escaped in fiery froth, and solidified into the rough "*aa*," and was carried down the valley on the surface of molten lava, which, in places, is as much as 600 feet thick. The eruption was a prolonged one, and consequently the later lava had a prolonged simmering in the chimney or fissure, during which it parted with most of its vapour, and when finally it flowed out it had little left, not sufficient to form a layer of froth, but only a few "giant's children" or blow holes, of which some very fine examples occur near the craters. This sequence of events does not appear always to obtain. Near Hekla we saw a stream of lava scoriaceous on the steep slope near its point of eruption, but corded with most beautiful regularity in parts where it had flowed tranquilly on the plain, after parting with most of its vapour, and escaping from under the crust higher up.

We returned from the Skapta by way of the Fjallabaksvegr, a desert route of about ninety miles from the last house on the one side to the first on the other, and thence by Hekla, the Geysir, and Thingvalla; but these have been often described, and space is wanting.

It is currently believed in Iceland, and was stated in some of the public prints at the time, that a volcanic eruption or earthquake had taken place at Cape Reykjanæs in October, 1887, by which a large new *giá* or chasm had been formed, separating a large rocky promontory, almost deserving the name of a mountain, from the main cape on which the lighthouse stands. This chasm, at least 50 feet wide, was pointed out to the author from a passing steamer, the captain declaring that he remembered the rocks before they were rent asunder. Here, then, appeared to be a case of the formation of one of the giás or chasms which form such a characteristic feature of Icelandic geology. There are several such on the Reykjanæs peninsula, huge chasms several feet wide, and of unknown depth, stretching for miles across the lava desert of which the district is composed. In this district they usually, though not always, have a throw of a few feet or yards, but one of these at Thingvalla, more in the centre of the island, the Allmanagiá, has a throw of about 100 feet. In this case, the author is satisfied that the *giá* is due to the unequal settling of a crust of lava formed on the surface of a still fluid mass, which had found an outlet and flowed out after the solidification of the surface. He is not prepared, however, to say that this explanation will hold good in the case of all the rifts on the Reykjanæs peninsula. It certainly would not in the case of the great fissure from which the Skapta lava was erupted. Consequently, any clear case of the formation of a new *giá* in strata long cooled and solidified, would have been well worth investigation.

From a careful examination of the locality, it appeared that no fresh formation of a *giá* has taken place, but that certain small portions of the rock on which the lighthouse stands had been loosened, partly by ordinary denudation, and partly by earthquakes, which are frequent here, and had fallen on to the

beach. The strata of partly consolidated volcanic ash, &c., are quite continuous at the end of the small cove or recess between the two large rocks above referred to.

DISCUSSION.

The CHAIRMAN said Dr. Anderson need not have apologised for bringing this paper before the Society, on the ground that the subject of volcanoes was not suitable for a Society dealing with arts, manufactures, and commerce, because many products of volcanoes were of great use in the arts. For instance, there was the volcanic ash called *pozzuolana*, which was quarried in Italy for making a very strong kind of cement, and deposits of a similar kind were worked on the banks of the Rhine, and exported to different countries. Then there was pumice-stone, and various building stones and paving stones were worked in France and Australia, which were simply volcanic lava. The old millstones, again, and querns were obtained from lavas on the banks of the Rhine, and obsidian was used in some countries for [illegible]ves and arrow heads. Then there was sulphur, [illegible] the jets of carbonic acid gas given off from holes in the ground near the Rhine were compressed into a liquid state, and sent to all parts of the world. Turning to Italy, again, boracic acid was obtained in the well-known district of the Maremma, and even the old quarries from which millstones had been quarried in Germany were found to make excellent cellars for cooling beer. Lastly, the four great deposits of diamonds in South Africa were supposed to be in the necks of old volcanoes. He could fully endorse Dr. Anderson's statement, that the Scotch boats were not to be depended on, for when he was stopping at the north-eastern corner of Iceland, the captain of the Scotch boat had promised to put in to pick him up on a certain day, but after waiting day after day, keeping a man out at night in a boat waiting for the steamer all in vain, he and his friend had to make their way across the island, by way of the Sprengisandr, a route which was hardly ever traversed; and when they did get a boat at Reykjavik, the navigation was very faulty, for they very nearly ran down the west coast of Scotland instead of the east. Dr. Anderson had omitted a picture of one of the public buildings of Reykjavik, of which he (the Chairman) was, for a short time, an inhabitant, viz., the jail, though, luckily, not as a prisoner. Having come across the Sprengisandr desert with his friend, and been about seven days without taking off their clothes, they were anxious, on arriving at the capital, to have a warm bath, but on making inquiries they found that the only place where such a luxury could be obtained was the jail, and they therefore went there, were hospitably received, and obtained what they wanted. He thought full justice had hardly been done to the Iceland ponies, which were exceedingly surefooted, and he had, after some misgivings, and being very much inclined to dismount, ridden down some most precipitous places, probably with more safety than he he could have secured on foot. These ponies were very clever also in going over marshes; on one occasion they were riding for some hours over a spongy marsh, where they expected every minute that the pony would be engulfed, but he was left to himself, and he managed, by some instinct, to pick his way over it in safety. Anyone going to Iceland, however, should be very careful about the stuffing of his saddle. An English saddler, used to a well-fed horse or pony, could hardly understand the kind of razor-backed animal you sometimes meet with in Iceland at the beginning of the season, which, having been half-starved during the winter, would be sure to get galled with an ordinary saddle. Dr. Anderson had been very fortunate with his guide, but he had not mentioned a matter which he (the Chairman) had found very annoying, and that was the difficulty in making a start. You might arrange overnight to start at seven in the morning, and be very lucky if you get off at eleven; and he recollected, on one occasion, having arranged to start at nine, they did not get away until three o'clock in the afternoon. There was one other bridge in the island besides the one which had been shown; this crossed a steep gully or chasm of the river Jökulsá near Seydisfjordr, and was known by the name of Brú, or bridge. He could endorse all that had been said as to the hospitality of the people. After starting on that unfortunate day, at 3 o'clock, and riding until 3 o'clock next morning, there being quite enough light in the summer time, they arrived at a farm house, and after waking up the people, the farmer got up with all his family, made them coffee, and his friend having the only bed in the guest room, he was conducted to an upper room, from which he judged by the surroundings that one of the farmer's daughters had only just been ejected. Sometimes they could not find sufficient accommodation in the farm houses, and, on one occasion, were then billeted in the church at Reykir, where they managed to sleep pretty comfortably. The guides were certainly excellent; they had one named Paul, who had the previous year accompanied Mr. Watts in his expedition, and he was thoroughly well qualified for his duties. When crossing the Sprengisandr on the worst day, when they had practically no food for the ponies, and one had to be killed, they had to cross 60 streams coming out of the glacier, and although the fords changed every year, and the guide had only been that way once or twice before, and not at all that year, he was able, by the look of the bank or the look of the water, to find where they could cross safely, and he gave them strict injunctions to follow exactly in his track; through failing to do so, his friend was very nearly washed away. Not only were Yorkshiremen of the same race as the Icelanders, but the inhabitants of the Isle of Man also came from the same stock, as was shown in the names. For instance,

Laxa, which simply meant a salmon river; and there was more than one Laxa in Iceland. There was, again, the further resemblance that, in the Isle of Man, the laws were promulgated in the open air, on the Tynwald-hill, once a year. They were much indebted to Dr. Anderson for this paper; and it was very interesting to a miner or geologist to see these photographs of great cracks and fissures, which enabled one to understand how similar operations had gone on in past times, and how they had subsequently become filled up with mineral matter.

Mr. E. MAGNUSSON said he could agree with nearly everything Dr. Anderson had said, though perhaps he had been inclined to generalise a little too freely. He had visited the part of the country which was most backward, being the most difficult of access; and therefore what he had seen there would not be true of the whole island. In some places the people, though descended from those who had long left the stone age behind, had found it necessary, because it was so difficult to procure iron, to create a new stone age for themselves. They were the creators of a new stone age, not the followers of a tradition. The volcanic nature of the country was exceedingly striking, the most interesting spot being the Thingvalla; and he would call attention to one peculiarity of it, which Dr. Anderson had perhaps observed. The valley was bounded on the two sides by two enormous rifts, the western being called "The Rift of the People," and the eastern, "The Raven's Rift." Between these two rifts the valley of Thingvalla fell down in a scoop, and it was evident that at one time the whole valley had been a volcanic bubble, and instead of being formed, as Dr. Anderson seemed to think, at the time the lava was flowing, he thought it was formed through a natural catastrophe—an earthquake—in later times, long after the lava itself had formed a strong roof over it. The proof of that could be seen in the fact that when you travelled over the lower part of the valley, you found that the roof, when it came down, split up into endless fragments, the cracks between which were filled up everywhere by the bottomless water rifts which had been mentioned. The history of the sulphur business in Iceland was not very commendable, and the less people were encouraged to believe that sulphur was to be had in Iceland the safer they would be. No doubt there were sulphur incrustations on the inside of the craters, but all geologists were agreed that the sulphur in the country was not a commercial article; it was not merely that it was difficult to get at, it was simply not there. Considering the short time Dr. Anderson had spent in the country, it was wonderful how he had observed so much, and how few errors he had made. One slight mistake was to suppose that the scythe he had seen standing against the wall of a farmhouse was one of a pair of stilts; the Icelandic scythe was a peculiar instrument, and looked very much like a stilt when turned upside down.

Mr. OLIVER WILLIAMS asked if the farmers in Iceland were much occupied in cattle rearing, or did they confine their attention chiefly to ponies. Also, if cement which could not be made there for want of fuel could be used if it were imported, or would the severe weather prevent it setting. He was glad to notice Dr. Anderson's reference to the bad effect of idleness, both in diminishing stature and in affecting the power to work, and would like to know if he thought it had at all affected the brains of the people. He had not been in Iceland, but had experienced just the same kind of hospitality in Siberia as had been mentioned by the Chairman.

Mr. JONATHAN HUTCHINSON, F.R.C.S., asked if Dr. Anderson could give any information as to the prevalence of leprosy in Iceland, a disease which still prevailed in Norway, and had only disappeared from our own island and the Orkneys within comparatively recent times. If it had disappeared in Iceland it would be very interesting to know under what circumstances it had done so, and if any change had taken place in the social habits of the people which would account for it. They were told by some that it was rapidly disappearing in Norway owing isolation and the prevention of contagion, but believed it was disappearing still more rapidly in Iceland, where no such measures were taken. There were two theories on this matter, one that it disappeared through the prevention of contagion, the other that it was owing to a change in the habits and particularly in the diet of the people, and that the disease was due to the consumption of badly salted fish. Now Bergen, in Norway, had the largest leper hospital in the world, and the largest fish market in the world, and it sent its fish to Naples and many other places where leprosy was still occasionally met with. Iceland seemed to be just the place for collecting evidence on this point.

Mr. DONALD suggested that the diminutive stature of the people might be partly accounted for by intermarriage, which would probably be prevalent in such a population.

Mr. WILLIAM GEORGE LOCKE said the Rev. Mr. McCormick, of Brighton, was just about publishing a book giving an account of his researches on leprosy in Iceland, which he had visited for the express purpose of studying the subject. He obtained a good deal of information from Mr. Paterson, the British Consul, and also from Dr. Skiding, and it appeared that, in 1800, out of a population of 50,000 there were 150 lepers; and now, out of a population of 72,000, there were only 25. On further inquiry, however, from an older and more experienced doctor, he was told that the disease was increasing, and that 1 per 1,000 suffered from it. There were no hospitals for leprosy, though Dr. Anderson who travelled through the island in 1824, said there were then four. Lepers were forbidden to marry, as the disease

was considered hereditary; but it was difficult to ascertain the actual state of affairs as the authorities did not like to say much about it. He (Mr. Locke) congratulated Dr. Anderson on his excellent paper, and the photographs which illustrated it. He had travelled in the country several times, and had read everything about it published in English, and a good deal in Danish. There were 30 volcanoes which had been active in historic times; and he believed no Englishman before had penetrated to the source of the lava that came out of the Shapka in the great eruption of 1793.

The CHAIRMAN then proposed a vote of thanks to Dr. Anderson, which was carried unanimously.

Dr. ANDERSON, in reply, said there was one useful purpose served by volcanoes which the Chairman had omitted to mention. At Santa Cruz, in the Canary Islands, a volcanic mass had risen two miles out to sea, and formed an excellent natural harbour. If the next eruption in Iceland would put out a nice barrier of lava, with a neck connecting it with the shore about the middle of the southern coast of Iceland, the volcano would do a great deal to redeem its character. He had the same experience of the Scotch boat as the Chairman; it did not come to take him at the time appointed, and he would have had a fortnight to wait but for the sailing of a cargo boat. The captain even of that refused to take him, but having the misfortune to fall down and break his leg the next morning, he was very willing to give a doctor a free passage in return for his surgical aid. He could not say anything about cattle rearing, but he saw very few cattle there at all; the live stock were chiefly sheep and ponies, and he heard from the guides that the farmers knew nothing about breeding the latter, but simply let them run wild, which accounted for the number of curious looking animals to be seen.

Mr. MAGUNSSON said the cattle ranged from one to forty on a farm, but they were not much seen.

Dr. ANDERSON said he certainly did not see many. He should imagine there would be no difficulty in using cement, as the weather was comparatively warm in summer. Mr. Williams had slightly misapprehended him. He did not attribute the weakness and small stature of the inhabitants to idleness, but to want of food and hardship continued from generations; and he thought their brains were quite equal to the average. Every Icelander could read, which was greatly to their credit, considering the difficulty of teaching in so scattered a population. Even in the poorest hovels you would see a nice little library. Intermarriage might have some influence, but he could not say anything about that for certain. With regard to leprosy, one doctor told him there were 40 or 50 cases in the island, but he seemed to be an official at Reykjavik, and he probably minimised it, because he told him of at least two or three more. The people soon found out that he was a doctor, and he was generally delayed for three-quarters of an hour or more in the morning by the large number of patients, with all kinds of extraordinary diseases, who were brought to be examined; there were two or three cases of coccuscysts, and several leper cases. One young woman came with a curious affection of the muscles of the thumb, which his friend thought was a case of atrophy, but remembering what he had seen at Bergen he said he should not be surprised if it was a case of leprosy, and asked her if she had any spots about her. She denied it, but in about half an hour her conscience struck her, and she came back and said she had, and he found on the arm one of the characteristic painless spots which, corresponding with the atrophy of the muscle, was the early sign of leprosy. But in the presence of such an authority as Mr. Hutchinson he did not feel that he could say anything of any value on this subject. These people were on the seashore and were probably fish eaters, but everybody on the island was more or less near the seashore, and probably ate fish.

Miscellaneous.

LIVE STOCK AT THE CHICAGO EXHIBITION.

The following letter on the exportations of pedigree live stock to America has been addressed by Mr. Ernest Clarke, on behalf of the Agricultural Committee of the Royal Commission for the Chicago Exhibition of 1893, to the Royal Commissioners, and has been forwarded by them to Chicago for the consideration of the authorities of the Exposition:—

12, Hanover-square, London, W.,
15th March, 1892.

SIR,—1. In compliance with the request of the Royal Commission for the Chicago Exhibition of 1893, the Agricultural Committee have been for some time engaged in endeavouring to stimulate public interest in the work of the Agricultural Department of the Exposition, and in particular, to attract entries from the breeders of this country for the Shows of Live Stock which are to be held in connection with the Exposition in the autumn of 1893.

2. The councils of several of the more important of the breed societies of the kingdom have already communicated to the Committee their wish to offer champion prizes or gold medals for the best specimens exhibited of their respective breeds, and the Committee had reason for hoping that this example would have been very generally followed.

3. They cannot but feel, however, that the Order

of the 22nd January, 1892, issued from the United States Treasury Department with regard to importations of animals for breeding purposes, not only prejudices the offers of champion prizes already received by the Committee, and makes improbable the receipt of others, but is likely to interfere very seriously with the chances of an adequate representation of the British breeds of live stock at the Exposition.

4. The Order in question directs that "On and after April 1st, 1892, no animal which is brought into the United States from foreign countries for breeding purposes shall be admitted free of duty, unless the importer furnishes a certificate which shall contain a pedigree in the form hereafter given, showing that the ancestors have been recorded in a book of record established for that breed for five generations on the side of the sire, and four on the side of the dam." . . . . "Unless such certificate of pedigree is produced, therefore, the animal shall be considered dutiable as not being pure-bred of a recognised breed, and duly registered in the book of record established for that breed." The form of certificate required to be furnished by the importer has spaces not only for the animal itself and its stud or herd-book number, but for the pedigrees (with numbers) of five generations of ancestors on the side of the sire, and four generations on the side of the dam, and it must be signed by the secretary of the stud or herd-book as a correct pedigree of the animal.

5. The Committee think the Treasury Department can hardly have been aware, when promulgating this Order, that its effect will be to create a distinction (absolutely unjustified by facts) between the breeds of live stock recognised in this country as pure. With but few exceptions, the conditions of admission of animals to the British stud or herd books mentioned in the Treasury Order do not exact a pedigree so lengthy as that contemplated by the Order. Although in certain particular cases, where the pedigrees of their animals have for a long period been carefully recorded by individual breeders, it might be possible for secretaries of stud or herd books officially to fill up the required certificate, yet in the great majority of instances such a certificate could not be obtained by the importer, notwithstanding that his animal had been duly accepted by the responsible authorities of the British book of record of the particular breed as a pure-bred animal, qualified for entry in their stud or herd book.

6. The interest of the Agricultural Committee of the Royal Commission in this matter is of course confined to the probable effect of the Order upon the number of animals sent over from this country to compete at the Live Stock Shows in connection with the Chicago Exposition, though, largely consisting as the committee does of the representatives of the different British breeds of live stock, it cannot ignore the very serious consequences which the enforcement of the Order will have upon the exportations of pedigree animals from this country to America.

7. The cost and difficulties of sending animals to the Chicago Exhibition are already so great, that none but those who see a prospect of selling the animals sent, or others of the same kind from their studs or herds, are likely to be attracted to send entries. And if, to these difficulties, be superadded an import duty, which animals of one particular breed escape, and animals of another equally pure and well-established breed have to pay, the Committee feel that, so far as this country is concerned, the expressed aspiration of the Chicago Executive, that "every species, breed, variety, or family of animals, domesticated or otherwise, throughout the world, be represented at the Exposition," will not be satisfactorily realised.

8. The Committee have therefore instructed me to communicate their views on the subject to the Royal Commissioners, and to suggest that the Chicago Executive should be invited to ascertain and state specifically whether the Treasury Order of the 22nd January, 1892, which refers to the importation of animals "for breeding purposes," will be held to apply to animals sent from this country to Chicago "for *exhibition* purposes."—I am, Sir, your obedient servant,

(Signed) ERNEST CLARKE,
Honorary Secretary.

The Secretary
of the Royal Commission,
for the Chicago Exhibition.

RUSSIAN SUNFLOWER INDUSTRY.

The sunflower, as a garden plant, has been known all over Russia for many years, but only in certain districts has it been cultivated on a large scale as an industry. The first cultivation of sunflower seed for commercial purposes began, says the United States Consul General, at St. Petersburg, in 1842, in the village of Alexeievka, in the district of Berutchinsk, Government of Voronezh, by a farmer who was the first to obtain oil from the seed. This farmer soon found many followers, and the village of Alexeievka soon became the centre of the new industry. The Government of Voronezh is even now the chief district in European Russia for the growing of the sunflower. Besides the district of Berutchinsk, this plant is cultivated on a large scale in the districts of Novokhopersk, Ostrogoshk, Bobroosk, Valouisk and Korotoiaks. From the government of Voronezh the cultivation of sunflowers spread to the adjacent governments of Tamboo and Saratov, where there are large fields cultivated with this plant, particularly in the latter government. The people of the province of the Don and the government of Simbersk and Samara are more or less engaged in this tiade, in fact in the entire south-east of Russia the sunflower furnishes a prominent product of the farm. Two kinds of sunflower are grown in Russia—one with small seeds, used for the production of oil, and the other with larger seeds, con-

sumed by the people in enormous quantities as dainties. In the district where the seed is cultivated on a large scale, the plant has been continually grown on the same soil for many years in succession, thus producing a special disease of the plant. The sunflower seed is used principally for obtaining sunflower oil, which, owing to its nutritious qualities, purity, and agreeable flavour, has superseded all other vegetable oils in many parts of the country. In general, the cultivation of the sunflower in Russia is considered to be very profitable. At the average yield of 1,350 lbs. to the acre, and at the average price of ¾d. a pound, the farmer receives an income of about £4 an acre, and this income can be increased in those districts where the grower himself is engaged in producing the oil from the seed. The substance remaining from the oil manufacture, or sunflower cakes, being used as cattle food, is also a valuable product. These cakes, however, have a comparatively small demand in Russia, but are largely exported to foreign countries, principally to Germany and England. The Government of Saratov, for instance, exports about 2,000,000 lbs. of sunflower cakes to different countries, where a further quant[illegible] oil is extracted from them before being used [illegible]tle food. The sunflower shells being used fc[illegible]ing purposes, form an article of trade in several districts. The seed cups are not wasted, but are used as food for sheep. The peasants in the Government of Tambov are increasing the cultivation of the sunflower owing to the following reasons. There is a steadily increasing demand at home and abroad for the seed, thns making the industry a profitable one, especially as Russia is the chief source of supply. As above mentioned, the sunflower is cultivated principally for the oil. If the cultivation is made with care, and if proper precautions are taken in drying, cleaning, and pressing, sunflower oil is equal to the French table oil in colour, flavour, and taste. At first sunflower oil did not meet with public favour in Russia, but later on, owing to its good qualities and cheapness, it took the place of the oil of poppy seed; but for a long time hemp-seed oil competed with it, owing to the fact that the lower classes, who for many years had used the hemp seed oil in the preparation of various dishes, and who had long learnt to relish it, were not disposed to give it up. Now, however, public opinion has changed, and sunflower oil is preferred by the masses to all other table oils in Russia. The process of oil-making is as follows. The seed being brought to the oil mill, is thoroughly cleaued and sorted. They are passed under millstones, specially prepared for the purpose, in order to release the seed from the shells. After this the seed is properly dusted and put under a press, and, later on, into a mixer, where the seed is turned into a compact mass very much like paste, which passes into vessels heated by steam. From these vessels the paste is taken out and wrapped in a thin web, made of camel hair, and put under a press, by which the oil is squeezed out and conducted by pipes into tanks. The total number of oil mills in Russia was, according to the last account, 104. From this number 85 were applied solely to obtaining sunflower oil. In 24 of these mills steam is used, and in others only manual power. The largest mill is at Saratov, and it produces 1,500,000 pounds of oil annually. There are two kinds of oil obtained from the sunflower seeds. The better kind is sweet, and more expensive, the inferior having a bitter taste. The difference in the price of these two qualities is about one halfpenny a pound. The oil remaining from the oil production or the waste, and not used as food, is applied exclusively to certain industries. The sunflower stalks, gathered from the fields, and dried in piles, have entirely replaced firewood; in fact, these stalks are preferred even to pinewood, producing a quick and hot-flame fire. About 2,000 pounds of such firewood are gathered from an acre of land, thus adding a great boon to a district where wood is scarce. Sunflower shells are also used for heating purposes, not only in private houses, but in large factories as well. They are burned in ovens specially prepared for their consumption. The ashes of the sunflower contain a high percentage of potassium. The experiments of Hermbstedt have proved that 1,000 pounds of dried stalks yield 57·2 pounds of ash; and from 1,000 pounds of ash are obtained 349 pounds of the best potassium. As a food for cattle, sunflower cakes are looked upon as the best in Russia; they are considered better even than hemp or rape-seed cakes. According to chemical analyses, the sunflower cakes from the Government of Saratov contain:—Azotic substances, 42·31 per cent.; oil, 14·7 per cent.; and ashes, 5·12 per cent. The dried seed-cups, if ground, are used in many districts as food for cattle, and particularly for sheep, with great success.

PALM OIL.

The total import of palm oil into England is about 50,000 tons, valued at over £1,000,000, but it is considered that this is an exceedingly small commerce compared to what might be the case were the enormous resources fully, or even moderately, utilised. For miles along the west coast of Africa, extending between Cape Bianco and St. Paul di Loando, there are vast forests of palms, the oleaginous fruit of which has, for centuries, rotted unused upon the ground. The oil palm forests at the back of the coast line of Cape Palmas and Elmina are said to be practically inexhaustible; and so also in the neighbourhood of Fernando Po, immense tracts are covered with the trees.

Lagos furnishes the purest oil; for there are in commerce regular and irregular oils. When analysed, if the water and impurities exceed 2 per cent., an allowance is made; for often these oils contain 10 to 15 per cent. of water and impurities.

Palm oil is eaten as butter by the natives, and used for anointing their bodies. Here it is used in the manufacture of soap and candles, and in South Wales in the preparation of tin plates. Its non-drying qualities render it valuable as a preservative of the surface of the heated iron sheet from oxidation until the moment of dipping into the bath of melted tin, the sheets being rapidly transferred to that from the hot oil bath, which consists almost entirely of palm oil.

In 1871, as well as in 1880 and 1891, the imports of palm oil into the United Kingdom exceeded 1,000,000 hundredweight. From 10,000 to 15,000 tons of palm oil are shipped direct from Africa to the Continent. The price of the oil has ranged from 35s. per cwt., in 1883, to 23s., in 1890.

Correspondence.

INDIA AND THE HYGIENE CONGRESS.

Sir William Moore is mistaken as to the authorship of the paper on "Indian Factory Legislation," read at the Hygiene Congress. The official "Reports of the Meetings and Discussions" show that the only paper on the subject was read by me, and that Dr. Bahadhurji, the delegate of the Bombay Millowners' Association, merely joined in the discussion. Dr. Bahadhurji has since greatly added to and amplified his remarks, and published them under the title of "Factory Labour in Indian Spinning and Weaving Mills: Paper read before the Congress of Hygiene and Demography"—rather an Oriental way of proceeding. Dr. Bahadhurji's statements in this publication, and in letters to the Press, have been contradicted and disproved *seriatim* by Mr. N. M. Lockhanday, President of the Bombay Mill Hands' Association, who was appointed Local Member of the India Factory Commission of 1890 for the Presidency of Bombay. The value of Mr. Lokhanday's judgment upon the discussion between Dr. Bahadhurji and myself is evidenced from the way his appointment was alluded to in a leading article of the *Bombay Gazette*, where it was stated that "Mr. Lokhanday, though no longer connected with the mills, was for some years an operative, and he has since been in constant contact with the mill-hands. It is easy enough to call him a professional agitator, but he stands alone as an educated man able to give expression, from his personal knowledge, to the facts of mill life, and to the wishes of the mill operatives." In his series of articles on the subject, which appeared in the *Din Bandhu* between October 25th and December 20th, 1891, Mr. Lokhanday endorsed my statements. This is not surprising, as they were taken from Blue-books and other official publications, containing the reports of experienced and trained factory inspectors, sent out from England to inspect and report upon Indian factories, and the evidence given before various Factory Commissioners in India by medical men, mill managers, and operatives, whose evidence has never been publicly challenged or controverted. Dr. Bahadhurji has been in no way officially or in his private practice connected with the mills. His knowledge of them is recent, and was gained in a few flying visits, in order to represent the Bombay mill-owning interest before the Congress, and his statements are referred to by the acknowledged expert, Mr. Lokhanday, as "a patchwork of misstatements and contradictions."

HOLT S. HALLETT.

1, Chilworth-street, W.

Obituary.

DR. TIDY.—Charles Meymott Tidy, M.B., the eminent chemist and analyst, died on Tuesday night, 15th inst. He was a son of the late William Callender Tidy, M.D., of Hackney, and for a short time continued his father's practice at that place. He became a member of the Royal College of Surgeons in 1864, and took his M.B. degree in 1866. Shortly afterwards he was appointed joint lecturer on chemistry with the late Dr. Letheby, at the London Hospital, and subsequently he became Professor of Chemistry and of Medical Jurisprudence and Public Health at the same hospital. He was, at the time of his death, Official Analyst to the Home-office and Medical Officer of Health for Islington. Dr. Tidy was a member of the Society of Arts. H. delivered a course of Cantor Lectures on the "Practical Application of Optics to the Arts and Manufactures and to Medicine," in November and December, 1873; and on April 14th, 1886, he read his elaborate paper on "The Treatment of Sewage," which was discussed at three adjourned meetings, viz., on May 5th, and December 1st, and 15th, 1886. In 1889, the Swiney Prize was awarded to Dr. Tidy for his work, entitled "Legal Medicine." In 1872, he, in conjunction with Dr. Woodman, read a paper before the Royal Society, on "Ammonia in the Urine in Health and Disease." He published, in 1878, a "Handbook of Modern Chemistry," a second edition of which appeared in 1887. Dr. Tidy was called to the Bar at Lincoln's-inn a few years ago, and he held the office of Reader of Medical Jurisprudence to the Inns of Court.

General Notes.

DURABILITY OF MODERN PIGMENTS.—It is to be regretted that a sentence commenting adversely upon a painting medium sold by a particular manufacturer,

should have been allowed to appear in a letter, printed on page 387 of last week's *Journal*. Messrs. Charles Roberson & Co., the manufacturers of the medium, has complained to the Secretary of the criticism in question. Under these circumstances, it seems only fair that an opportunity should be given for the defence of the article which has been attacked. Messrs. Roberson refer to a note which appeared in the *Athenæum* of July 21st, 1866, in which the late Mr. E. M. Ward, R.A., stated that the whites in his well-known picture of the South Sea Bubble, painted 20 years before with Roberson's medium, were at that time as pure and as brilliant in its character as on the day the picture was painted. This picture is now in the National Gallery, Trafalgar-square, so that persons interested in the subject can judge for themselves whether there has been any degradation of the original brilliancy. Messrs. Roberson further state that as this medium has been extensively employed as a vehicle in oil painting for more than fifty years, any number of examples of its durability may be referred to.

RECEIPTS OF PARIS THEATRES IN 1891.—According to a report in the last number of the *Bulletin de Statistique et de Legislation Comparée*, the gross receipts of all the places of entertainment in Paris in 1891 amounted to £943,986, as compared with £920,536 in 1890, and £1,285,556 in 1889. It should, however, be remembered that the latter was the Paris Exhibition year, when the receipts of the various places of amusement would naturally exceed those of an average year. During last year the largest amount realised by any of the places of entertainment in Paris was £122,738—taken at the Opera-house, a building capable of holding 2,200 persons. The next in order of importance was the Comédie Française with £79,140; and after it came the Opéra Comique with £70,523; the Hippodrome with £63,295; the Théatre des Variétés with £45,320; and the Bouffes Parisiens with £45,222. At the Nouveau Cirque £37,100 were taken; at the Cirque Franconi, £29,972; and at the Folies Bergère, £28,850.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 23.—GILBERT R. REDGRAVE, "Manufacture and Industrial Application of Flexible Tubing." Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Deputy Chairman of the Council, will preside.

MARCH 30.—EWING MATHESON, "Foreign Exchange."

APRIL 6.—ROBERT S. MCCORMICK, Resident Commissioner for Great Britain from the World's Columbian Exposition, "The Future Trade Relations of Great Britain and the United States."

APRIL 13.—Prof. ROBERT WALLACE, "Egyptian Agriculture."

Papers, the dates of reading of which are not yet fixed:—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

FOREIGN AND COLONIAL SECTION.

Tuesdays, at Half-past Four or Eight o'clock; due notice of the hour will be given:—

APRIL 5.—The Rev. JOHN MCLEAN, D.D., "The Red and White Races in Manitoba and the North-West." The paper will be illustrated by lantern slides, and a collection of Blackfoot and Sioux Indian articles. 8 p.m.

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "Australasia: its Progress and Resources." 8 p.m.

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade." 8 p.m.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MARCH 24.—G. H. M. BATTEN, formerly of the Bengal Civil Service, "The Opium Question." Sir JOHN STRACHEY, G.C.S.I., C.I.E., will preside.

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12.—C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. WILLIAM ROBINSON, M.E., Assoc-M.Inst.C.E., "The Uses of Petroleum in Prime Movers." Four Lectures.

LECTURE IV.—MARCH 21.—*Oil Fuel and Gaseous Fuel for Steam-boilers.*—Safe heavy oils available—Different methods of burning oils—Injector-burners—Evaporative power of oil fuel.—Advantages and disadvantages of liquid fuel on steamships—Transport and storage of petroleum—Other uses of petroleum for power purposes.

BENNETT H. BROUGH, Assoc.R.S.M., F.G.S., "Mine Surveying." Three Lectures.

LECTURE I.—MARCH 28.—*Introductory.*—Nature of mineral deposits, and the modifications of the methods of surveying required in different mines—Accidents due to inaccurate surveying—Historical sketch—The oldest mine plan—The divining rod—The use of the magnetic needle in mapping deposits of iron ore.

LECTURE II.—APRIL 4.—*Surveying.*—The compass—Ancient forms of compass—Various forms of miner's dials and theodolites—Use of aluminium for mine-surveying instruments—Supply of light for reading the verniers underground.

LECTURE III.—APRIL 11. — *Levelling.* — The level and staff for underground use—Applications of levelling in mining operations—The Carrara marble railway—Aërial wire ropeways—Hydraulic mining ditches—The St. Gothard, Mont Cenis, and Croton aqueduct tunnels—The Ernst-August adit-level—Mapping bore-holes.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Prof. William Robinson, "The Uses of Petroleum in Prime Movers." (Lecture IV.)

British Architects, 9, Conduit-street, W., 8 p.m. Prof. Aitchison, "Byzantine Art."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Dr. Phené, "Certain Traditions in Heathen Mythology."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Klein, "Bacteria, their Nature and Functions."

TUESDAY, MARCH 22...Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m. Annual Conference. Opening Address by the President; reading of papers and discussion. 8 p.m. Confereuce continued. Demonstration of Electric Light Photographs, by Mr. Van der Weyde.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture X.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Alex. R. Binnie, "Mean or Average Annual Rainfall, and the Fluctuations to which it is Subject."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. Mr. J. Theodore Bent, "The Archæology of Zimbabwe Ruins."

WEDNESDAY, MARCH 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Gilbert R. Redgrave, "Manufacture and Industrial Application of Flexible Tubing."

Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m. Conference. Reading of Papers, and Discussion (continued).

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 20, Hanover-square, W., 8 p.m. Dr. R. A. Douglas Lithgow, "Anglo-Saxon Alliterative Poetry."

THURSDAY, MARCH 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. G. H. M. Batten, "The Opium Question."

Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Lantern Slide Exhibition.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. B. A. Whitelegge, "Epidemic Waves." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

FRIDAY, MARCH 25 ... United Service Inst., Banqueting-house, Whitehall, S.W., 3 p.m. Colonel T. B. Shaw-Hellier, "The Organisation of Military Bands, and on Military Music." The lecture will be illustrated by the Kneller-hall Band.

Royal Institution, Albemarle-street, W., 8 p.m. Wekkly Meeting, 9 p.m. Dr. John Evans, "Posy Rings."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. G. Lambert Gibson, "The Seafield Dock and the Kirckaldy and District Railway."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. Herroun, "The Electro-motive Forces of Gold and Platinum Cells." 2. Mr. E. S. Bruce, "A New Instrument for showing the Effects of Persistence of Vision." 3. Mr. R. W. Paul, "Some Electrical Instruments."

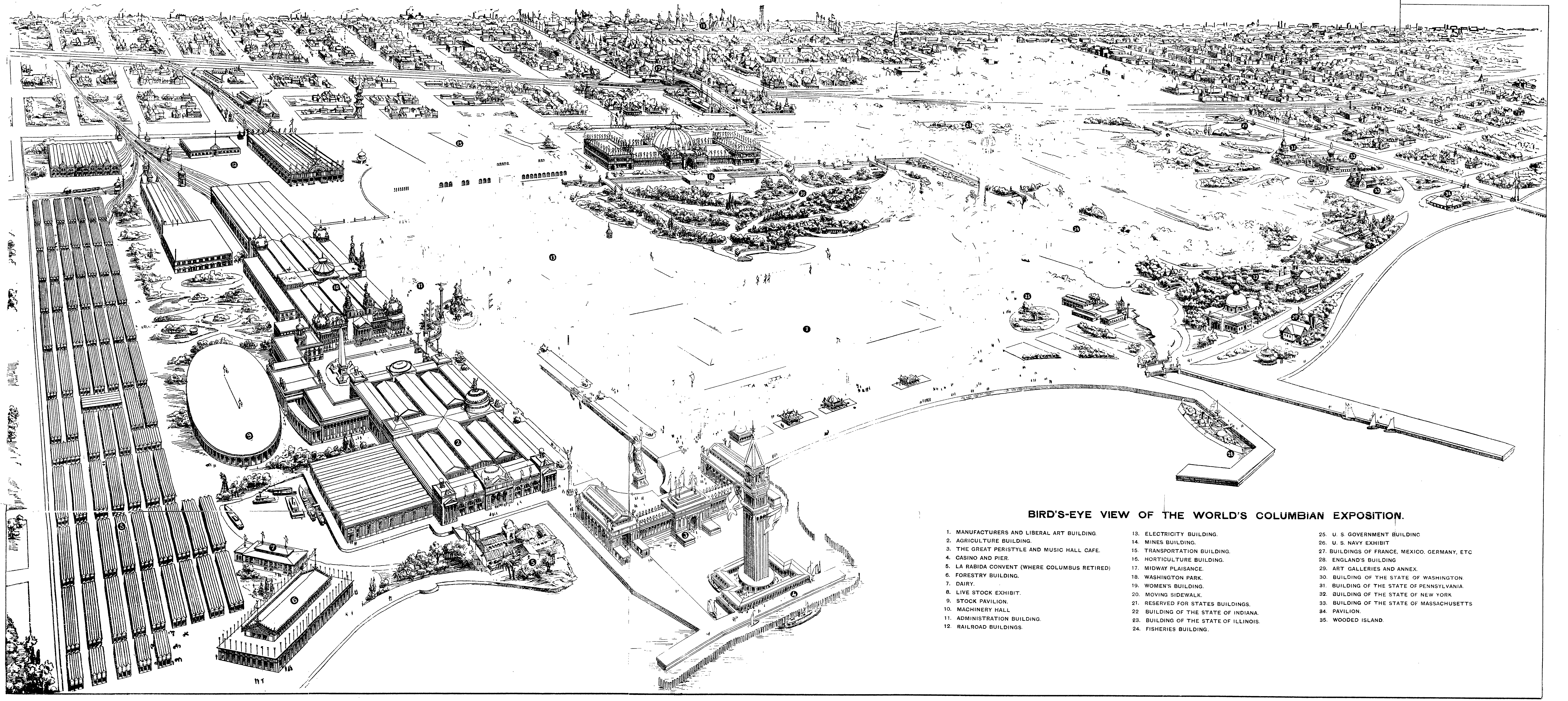
SATURDAY, MARCH 26...Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Prof. J. Norman Lockyer, "Astronomy and Mythology of the Ancient Egyptians." Lecture I.

Botanic, Inner Circle, Regent's-park, N,W., 2 p.m. First Spring Exhibition.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. F. Bridge, "Dramatic Music from Shakspere to Dryden."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

SUPPLEMENT TO THE JOURNAL OF THE SOCIETY OF ARTS, 25TH MARCH, 1892.



BIRD'S-EYE VIEW OF THE WORLD'S COLUMBIAN EXPOSITION.

1. MANUFACTURERS AND LIBERAL ART BUILDING.
2. AGRICULTURE BUILDING.
3. THE GREAT PERISTYLE AND MUSIC HALL CAFE.
4. CASINO AND PIER.
5. LA RABIDA CONVENT (WHERE COLUMBUS RETIRED)
6. FORESTRY BUILDING.
7. DAIRY.
8. LIVE STOCK EXHIBIT.
9. STOCK PAVILION.
10. MACHINERY HALL
11. ADMINISTRATION BUILDING.
12. RAILROAD BUILDINGS.
13. ELECTRICITY BUILDING.
14. MINES BUILDING.
15. TRANSPORTATION BUILDING.
16. HORTICULTURE BUILDING.
17. MIDWAY PLAISANCE.
18. WASHINGTON PARK.
19. WOMEN'S BUILDING.
20. MOVING SIDEWALK.
21. RESERVED FOR STATES BUILDINGS.
22 BUILDING OF THE STATE OF INDIANA.
23. BUILDING OF THE STATE OF ILLINOIS.
24. FISHERIES BUILDING.
25. U. S. GOVERNMENT BUILDING
26. U. S. NAVY EXHIBIT
27. BUILDINGS OF FRANCE, MEXICO, GERMANY, ETC
28. ENGLAND'S BUILDING
29. ART GALLERIES AND ANNEX.
30. BUILDING OF THE STATE OF WASHINGTON.
31. BUILDING OF THE STATE OF PENNSYLVANIA.
32. BUILDING OF THE STATE OF NEW YORK
33. BUILDING OF THE STATE OF MASSACHUSETTS
34. PAVILION.
35. WOODED ISLAND.

Journal of the Society of Arts.

No. 2,053. Vol. XL.

FRIDAY, MARCH 25, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The fourth and last lecture of the course on "The Uses of Petroleum in Prime Movers" was delivered by Prof. William Robinson, M.E., Assoc. M.Inst.C.E., on Monday evening, 21st inst.

On the motion of the Chairman (Mr. W. H. Preece, F.R.S.), the thanks of the meeting were voted to the lecturer for his valuable course of lectures.

The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 23rd inst. Present:— Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Deputy-Chairman of the Commission, in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederiok Abel, K.C.B., F.R.S., Sir Edward Birkbeck, Bart., M.P., Michael Carteighe, R. Brudenell Carter, F.R.C.S., B. Francis Cobb, Professor James Dewar, M.A., F.R.S., Major-General J. F. D. Donnelly. C.B., James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Alexander B. W. Kennedy, F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., F.S.A., with Sir Henry Trueman Wood, M.A., as secretary.

VIEW OF EXHIBITION GROUNDS.

With this week's number of the *Journal* there is issued a bird's-eye view of the Chicago Exhibition grounds, showing the general arrangement of the buildings, and the appearance of Jackson-park when viewed from the lake. Some of the details are, of course, subject to alteration, but no changes will now be made in the character of the principal buildings.

REPRESENTATION OF VICTORIA.

Lieut.-General Sir Andrew Clarke, the Acting Agent-General for Victoria, has informed the Royal Commission that it is the intention of the Victorian Government to take part in the Chicago Exhibition. The appointment of a Commission is now under consideration; in the meantime, the Government has expressed its willingness to provide a sum of £15,000, provided the exhibitors will contribute £5,000 to a total expenditure no exceeding £20,000.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Intending exhibitors are reminded that applications for space must be made immediately, as the allotment of space is now proceeding. Most of the available space is now occupied, and no time should therefore be lost by manufacturers desiring to be represented.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 15, 1892: Clements R. Markham, C.B., F.R.S., in the chair.

The paper read was—

PERU: ITS COMMERCE AND RESOURCES.

By F. A. Pezet.

The history of Peru is a subject which has more than once been brought before the

English-speaking world by authorised persons. Everybody at this advanced age knows perfectly well how Peru was discovered and conquered by the Spaniards, and how, after nearly three centuries of oppression, the country threw off the Spanish yoke, and established itself as an independent republic. In the brief space of time which I have at my command, I will not tire you with reminiscences of an historical nature; my object in appearing before you here to-day is, to try and interest you on behalf of my country. I come to you not as a Peruvian, to praise or advertise Peru, but as a friend of England and Englishmen; to prove that Peru is really what the many and learned historians, geographers, travellers, and writers in general have represented it to be—a country of great natural resources, with every possible condition to attain a commanding position amongst the nations of the world.

On the past riches of Peru I need not detain you. Guano and nitrate; these two words speak volumes, and can be considered as synonyms of wealth. I want to bring you to realise the present condition of the country, and its prospects for the future. Here we have a large country covering a surface of about 500,000 square miles, with a scanty and scattered population of 3,000,000 inhabitants. The last official census of Peru was made in 1876, and the returns showed a population of 2,699,945 inhabitants. But this figure is below the real number, as it has been ascertained that the Census Commission did not take into account the savage and semi-savage tribes of the mountain regions, and that, in some places of the interior, their work was very difficult through the ignorance of the people respecting the formation of the census, it being generally believed that the information required was for the purposes of taxation, a thing which the Indian greatly dreads. Although it is very difficult, if not impossible, to make a correct statement as to the uncivilised population of Peru, yet I consider that 350,000 would not be an exaggerated figure. Making allowances for the natural increase since 1876, and also for the decrease in consequence of the war with Chile, I will put down the absolute population of Peru to-day at about 3,000,000 inhabitants.

The aboriginal or Indian race which populated the country, to the extent of some 12,000,000 souls, when the Spaniards conquered Peru, still holds its own, although it has to a great extent degenerated through the miseries which, during centuries, it endured at the hands of its conquerors. The Indian race represents to-day about 57 per cent. of the entire population. In the interior of Peru it has kept in many places quite pure, not having mixed with any of the other races which have been brought into the country. There are tribes existing to-day with the old Incasic Indian features and characteristics quite distinct, and among these people there is a great and natural intellect. The other great race is the European or white, imported from Spain at the time of the conquest, and which has been ever on the increase since then. It represents to-day about 20 per cent. of the population, and is spread over the whole country in general, but specially on the coast.

As the Peruvian Indian was made to slave at the mines for his Spanish master, the Spaniards had to introduce Africans into Peru in order to till the ground and work on the cotton and sugar estates along the coast, and thus it was that the black race was brought into the country. Slavery having been abolished in Peru, in 1854, no more Africans have since come into the country, so the race has confined itself to some of the agricultural districts, and is now rapidly dying out. In its place there are the "mestizo" and "zambo" cross-breeds of blacks with whites and with Indians. The cross-breed of whites with Indians has produced the "cholo" race, which of all the castes is to-day the most numerous. These mixed races represent about 23 per cent. of the entire population, together with some 50,000 Chinese imported into the country since 1854, as agricultural labourers. The greater part of these have settled for good, and not a few of them have embraced the Christian faith and married with Indians, Cholas, Zambas, Mestízas, blacks and whites, thereby forming a diversity of new castes.

This immense country contains rich agricultural and pastoral lands, abundant mining wealth, vast petroleum fields, virgin forests, with every description and variety of timber. Its climate is as good as its soil is luxuriant.

The arid coast, the mountain ranges, and the fertile plains of the east have each a different climate, and in each region the European can find the temperature of his choice. The heat is never too excessive or lasting, and the cold can always be more or less avoided. The reports of the different Commissions which within the last two years have visited Peru, agree all on one point, and that is that the

country is admirably suited for European immigration on a large scale.

And here I come to the first and most important question for the development of Peru—immigration. Peru requires, and must have, not only skilled labour, but, above all, agricultural labourers. If the wealth of the country is to be turned to account, capitalists must make up their minds that their first step must be towards promoting an emigration current into Peru.

I do not intend to say that Peru in preference to any other country should be favoured by European emigration, no; but what I do insist upon is that Peru, on account of its great natural wealth, and its climate, offers a greater inducement to European settlers than perhaps any other South American country. In order to have an exact idea as to this, I will beg you to follow me on the map of Peru (kindly lent by the Peruvian Corporation, Limited). As you can see, Peru is situated between parallels 3° and 19° S. latitude, and between 68° and 81°, 20′ 45″ W. longitude. The exact boundary lines of Peru are not yet thoroughly defined, and this question is still the subject of international controversy, although the various Governments of the neighbouring States, as likewise that of Peru, are all agreed upon the necessity of arriving at a final settlement.

The country is divided into five distinct zones, which are formed by the two Cordilleras or chain of mountains nearly parallel to each other which traverse Peru from south to north. The coast, called *la costa,* is the zone which lies between the western chain, called Cordillera de la Costa, and the Pacific ocean; it is formed by an inclined plane from 30 to 60 miles in breadth, composed chiefly of sandy deserts, nearly destitute of vegetation, with several valleys, through which small streams run into the Pacific, affording the means of irrigation, as, on these sandy plains—in fact, over all this zone—it seldom rains.

La Sierra, or second zone, is the country which lies at a height of from 4,500 to 9,000 feet above the level of the sea. It commences on the western slope of the coast range, and also comprises all the country between both great chains. Its width varies from 60 to 120 miles. The chief characteristic of this zone is its temperate climate. Rain falls in great abundance during six months of the year—from October to April—but, notwithstanding this, the seasons, summer and winter, are the same as on the coast, with this difference, that the little rain and mist characteristic of the coast is only to be seen between May and September.

La Puna is the name given to the third zone, which many geographers consider part of the Sierra. The Puna is virtually the high tablelands or plateaus of the Andes, at a height of from 10,000 to 14,000 feet above sea level. Lake Titicaca, situated at 13,000 feet above the level of the sea, is one of the characteristics of this zone.

Cordillera is the zone formed by the mountain peaks of the Andes. It is perpetually covered by snow, but has patches here and there, where a kind of pasture grows, on which the vicunas and alpacas feed. Both the Cordillera and La Puna might well be comprised in the Sierra; but, as Professor Raymondi, Peru's great geographer and traveller, sets them up as distinct and separate zones, I have thought it wise to follow his plan.

La Montana, or Region de los Bosques—"Forest Region"—is all the country which, commencing on the eastern slope of the Cordillera, extends far away eastwards to the banks of the great rivers Amazon, Ucayali, Maranon, Pancartambo, Madera, and beyond them into Brazil. Each of these zones having special characteristics, it is easy to see that they must have great diversity of climate, and that their resources in the vegetable, mineral, and animal kingdoms must be as varied as they are profuse.

As already mentioned, in the Costa it seldom rains, specially in the northern extremity in the Department of Piura. The explanation of this phenomenon appears to be that the prevailing easterly winds, supposed to be a continuation of the south-east trade-winds, blowing across the continent, bring the clouds to the higher ranges of the Andes, by which they are broken, and the rain falls before reaching the coast. In Lima, the thermometer has never been seen below 60° at noon, and very seldom above 80°. The coolness that pervades the coast of this tropical region can be attributable to its snow-capped mountains, but is rather the effect of a thick mist called *garúa,* which covers, at times, the disc of the sun, and is partly owing to a cold current that flows northward from the Straits of Magellan to Cape Parinas. The difference between the ordinary temperature of the ocean in these latitudes, and that of the currents, is, according to Humboldt, at least 9°. In all this zone the sun is scarcely ever hidden by clouds for a day throughout the whole year, and the cool south-east breezes temper the heat of the sun

Walker & Boutall sc.

to such an extent as to make this region most habitable to Europeans.

The high plateaus of the Andes and the whole of the region which constitutes the Sierra contain, according to various travellers, among the most salubrious spots in the globe. The clearness of the sky and the purity of the air has made the Peruvian Sierra the great health resort of the Southern Continent.

The Montana has two distinct seasons—the dry season, from May to October, and the rainy season, from November to April. During the dry season, the heat is greater than in any other part of Peru. The mean annual temperature of the Amazon valley, from Manaos to Tabatinga, is 80°. Moyobamba, which stands 2,700 feet above the sea, has a mean annual temperature of 77°. Chachapoyas, situated 7,600 feet above the sea-level, has a temperature ranging from 40° to 70°. Although the Montana is traversed by a great many rivers, and the greater part of its virgin woods have not been explored, still the climate has been most favourable to the foreigners who have settled there and travelled through this region. The few cases of malaria and such fevers as are always associated with rivers, swampy forests, and uncultivated lands being almost confined to the smaller rivers, and quite rare on the banks of the Amazon, Maranon, Perene, Ucayali, and Palcazu.

Taking the country at large, it cannot be said to be unhealthy, it being a well-known fact that the great epidemics have never caused the number of victims in Peru as they have elsewhere. Cholera has never appeared in Peru, though it has raged very severely in the neighbouring countries. Yellow fever, that great scourge of nearly every tropical climate, has paid Peru few and far-between visits, but even then its number of victims compares favourably with those of other countries; and, what is more important, its last visitation, in 1881, was of small duration, and compared even more favourably with 1868 than that year's did with the great plague of 1854.

In some of the valleys there is, to a great extent, a sort of ague called *terciana*, arising principally from the marshes, but this illness cannot be considered as a serious one, and now it is generally combated with undoubted success by the most insignificant of local practitioners.

If old age is a test for a country's salubrity, then it must be confessed that Peru is really healthy, as not only amongst natives do people attain a ripe old age, but many foreigners, settled in different parts of the country, have lived to ages considerably above sixty.

Accepting the salubrity of the country and its suitability for Europeans, the first and natural question which arises is, to which zone of this country should Europeans go?

In order to answer this, I must first give an account of the natural resources of each zone, or, at least, of the Costa, Sierra and Puna, and Montana, as I do not suppose anyone would choose the snow-covered peaks of the Andes, the Cordillera zone, as a likely place to emigrate to.

By reason of the climatological and geological conditions of Peru, likewise of its great heights, distribution of the waters of its great rivers, and aridness of its coast, the three kingdoms—animal, vegetable, and mineral—are represented in each and all of the zones by special characteristics, which constitute of themselves undeniable sources of wealth.

The animal kingdom is represented in the Costa by the following live stock:—Horn cattle, goats, horses, mules, donkeys, wool-bearing animals, pigs, various breeds of dogs, deer, rabbits, vizcachas (a kind of hare), cats, and others. There are also partridges, pigeons, cuaresmeros (a kind of ruff), and many other game birds, as well as ducks, geese, turkeys, fowls, innumerable sea birds, and a great variety of good fish, both of salt and fresh water, the principal being *corbina*, which is one of the best fish extant; the *pejerey*, King Fish, an extra superior quality of smelt; *camarones*, *bonito*, *raya*, *pampano*, *lenguado*, *lisa*, and others, which are more or less familiar to Europeans as prawn, skate, sole, plaice, and haddock.

In the Sierra and Puna there are the vicuna, huanaco, llama, alpaca, all wool-bearing animals; also tigers, bears, wolves, panthers, jaguars, and other wild beasts; condors and other birds of prey. In the lower parts of the Sierra large stocks of cattle and sheep are raised. The animals found in the Montana are a variety of wild beasts; also horses, cattle, pigs, deer, rabbits, and wild hogs; the chinchilla, the nutria, and other fur-bearing animals; turkeys, pheasants, ducks, fowls, pigeons, geese, birds of paradise, and as great a variety of humming birds as are to be found in any part of the world, game birds unknown to the European; and also a large variety of reptiles, alligators, and fish of many kinds in the full flowing rivers. The *fauna Peruviana* has been well studied by Professor

William Nation, an Englishman, who has lived in Peru for a great many years. Up to 1881 he had catalogued 40,000 different specimens, including birds of passage.

The vegetable kingdom of the Costa has as principal products—sugar-cane, rice, cotton, bananas, maize, vine, alfalfa (a kind of lucern, or luxuriant clover), olives, tamarinds, potato, and sweet potato, all kitchen vegetables, and every kind of tropical fruits, as well as other indigenous ones.

In the Sierra, the products of the temperate zone, and many of those of the torrid zone, are cultivated; and, in fact, anything and everything may be cultivated in this privileged region. However, its principal products are potatoes, a plant indigenous to Peru, which grows wherever planted, and even in a wild state. The primitive potato is about the size of a hazel nut; and it is to the aborigines of Peru, who, by careful cultivation, developed it, that the world owes one of its principal food-roots. Wheat, barley, oats, alfalfa, maize, or Indian corn, which grows nearly everywhere, and, in some places, yields two crops a year. It supplies a staple of life for all classes, and not only affords food, but serves to make the national beverage, *chicha*. Yucca, rhea, or ramie, tobacco, coffee, cocoa, chinchona, cane, castor oil plant, and a very large variety of fruits, grains, and medicinal plants grow, wild and cultivated, in this zone.

The principal staples of the mountain are caucho, or india-rubber, which is exported *via* Brazil, by the river Amazon, tobacco, sarsaparilla, ivory-nuts, chinchona, coca, coffee, cocao, cane, and every tropical product known. The forests abound with valuable timber, woods, and plants, among which are found rare wood, for cabinet work, medicinal and oleaginous plants, dye woods, and textile plants.

On the cold, bleak Puna, the few crops that grow are the ichu, on which the wool-bearing animals indigenous to this region feed; barley, oats, quinua, olluco, oca, and other indigenous roots, which the natives use as food and for medical purposes.

Rich as the agricultural wealth of Peru is, it is as nothing when compared with the resources of the mineral kingdom. Providence, with a lavish hand, has hidden away in those great ranges of mountains which form the Andes, and, on their slopes, both eastern and western, as in the sandy hills and plains of the coast, and in the beds of the torrents and rivers in the Montana, all and every description of minerals, fossil substances, oils, and even precious stones.

The Costa is rich in petroleum, silver, copper, coal, sulphur, salt, guano, nitrate, lime, magnesia, borax, and gold is found in many places.

The Sierra is undoubtedly the region where the great mineral wealth of the country lies. The Andes can be said to be the gigantic monument raised by the hand of Nature to Mammon. Within those mountains are hidden the treasure which many struggle for; it was the sight of those treasures which made Spain, that great power of the 16th century, destroy an ancient empire, and cause to disappear a civilisation the like of which had never been seen or heard of. And yet to-day, when we come to consider that Spain during three centuries only managed to scrape the surface of those rocks, notwithstanding the fact that the value of the silver which the conquerors extracted amounted to something like £180,000,000 sterling, it shows how remarkably rich the country is; none of the mines having been worked on a very large scale, owing to the backward state of the mining industry in those days. It is believed by mining experts who have visited some of the principal silver districts of Peru, that the amount of high grade ores extant, nearly on the surface of the mines, or which can be extracted at a small cost, amount to considerably over 2,000,000 tons, while the poor or low grade ores which have been piled outside the mines worked by the Spaniards, and which, with modern appliances, could be treated with undoubted success, represent many hundred of thousands sterling. The Peruvian press and the Peruvian miners at large have lately been much excited over an invention of Senor P. F. Remy, a Peruvian mining expert, who professes to have found a new method for the treatment of blende, one of the most refractory ores, and which abounds greatly in Peru. Until now miners did not know what to do with such ores, the result being that they were turned aside and left there; but to-day, when Mr. Remy affirms that he has discovered the means of turning such ores into account, Mr. Gamboni, an Italian mining expert, challenges the priority of the invention, and actually states that he has an invention of his own for the treatment of the same ores. Both methods give the same result, but they differ one from the other in detail. According to last accounts it appears that Senor Remy proposes that an independent committee should study both pro-

cesses, and that its decision should rule. Mr. Gamboni does not accept this, claiming that when Mr. Remy applied for his letters patent, he had already patented his invention, and he further argues that Mr. Remy's so-called invention is only an application of his own.

But I have digressed from my main point. To return to my subject, I will just name the principal minerals which are to be found in the central region of Peru:—Silver, copper, gold, lead, cobalt, cinnabar, antimony, coal, salt, iron, nickel, marble quarries, arsenic, sulphur, alum, and petroleum.

In the Montana the gold washing and gold mines are the special feature; there are also known to exist emeralds, rubies, turquoises, and diamonds, in the eastern rivers, as the Incas used such precious stones to adorn their garments with.

By the preceding enumeration of the resources of the three kingdoms, it is obvious that Peru has been favoured with more than an ordinary share of the good things of this world, which, from a commercial and practical point of view, constitute a nation's wealth.

Undoubtedly few countries on the face of the globe can present a higher standard of natural resources, and, much less, can any present such resources placed in more suitable localities for the ends of commerce. When we consider the geographical position of the nitrate fields of Peru, the guano deposits, the immense petroleum fields, which lie on the sea coast inviting the hand of commerce and enterprise to carry them across the seas to less favoured climes, and we turn our minds to the agricultural resources and find that, notwithstanding the great and natural barrier which divides the coast from the Montana, each zone is favoured with outlets for the exportation of their large and varied products, on one side the Pacific Ocean, and on the other the great navigable rivers which empty their waters into the majestic Amazon, which flows into the Atlantic, it is impossible not to recognise the fact that we have before us one of the most favoured countries of the earth, and one which, if not to-day, to-morrow will force itself upon all men of enterprise.

To some, this may appear exaggeration. You may be inclined to think that my enthusiasm carries me away, or that in my earnest endeavour to serve my country, I trespass upon the limits of your credulity and overrate its resources. If all what I have said had not been already proved to the world at large by distinguished Englishmen and others who have visited the country, I might, indeed, be taken for an optimist, but, fortunately for Peru, and I may say for the commercial world, every one of my words can be confirmed by independent evidence.

Little wonder, then, that this country, notwithstanding the many drawbacks which have served as obstacles to its greater development, should be to-day attracting the financial world in such a noticeable manner as it does, and that it should be considered by many as the land of promise for the overgrowing population of European countries.

Judging from the description which I have just made, you will come to the natural conclusion that Peru offers, in each and all of its different zones, an ample field for enterprise; and that, therefore, the European, from a climatological and commercial point of view, could suit himself in no matter what part of the country.

Undoubtedly this is a fact; but I beg you to bear in mind that, while some parts of Peru have been more or less opened up to commerce and industry, there are others equally as rich, if not richer, where the soil is completely virgin, and where the skill and energy of the European is more necessary than in others. I refer to the transandine region; that is, the eastern slopes of the Great Cordillera and the Amazon Valley.

The coast has in itself the necessary elements to be self-supporting. This region has been more or less in actual development since the Spanish domination; and although there is a great scope for the advancement of its industries—notably, the agricultural—still it keeps apace with the general progress of the country. What the coast mostly requires is irrigation and the aid of capital. Its now seemingly arid plains can be turned into rich agricultural lands at a comparatively small cost; and these, properly cultivated, will produce abundance of crops, which will, within a short period, repay capitalists investing in such an enterprise.

The sugar, cotton, rice, and vine plantations of the coast could all be made much more profitable, and the production of these, the principal crops of this zone, could be increased within a very short time, if the owners of the estates had the necessary capital to invest in their properties. Unfortunately, many of the owners of the fine cane estates are in very straitened circumstances, owing to the present low price of cane-sugar in the European markets, and the heavy losses which they sustained during the war with Chile, when the whole trade and

commerce were paralysed, and to the general depression which followed closely upon that event. Another by no means unimportant factor for such a state of affairs has been the scarcity of labour, which, ever since the importation of Chinese contracted labourers was suspended, in 1875, has caused great prejudice to the agricultural interests at large; and last, but not least, the extravagant manner in which they commenced their business, the costly plant erected, and the anti-economical methods of production employed.

The valleys of the coast, as well as these sandy plains, must all, sooner or later, become great industrial and agricultural districts; and there is already a marked tendency in this direction, traceable to the last few years. Several schemes for the irrigation of these lands are now under consideration and study, and a few of the best estates are being worked on a larger scale than they have hitherto been. The prospects for the coast are even brighter; and, what with the recent discoveries of vast and rich fields of petroleum along the northern coast, this zone has every possible facility for attaining greater prosperity.

The depression in Peruvian agriculture dates since the abolition of slavery, in 1854; this most humane step having been taken during a civil war, and when one of the contending parties was in dire want of fighting men. Until that year the estates and plantations of the coast had been worked by the descendants of the African slaves, who had been imported into the country for the purpose by the Spaniards. These negroes, although a lazy lot, managed to work the plantations fairly well, and there is no doubt but that, up to that time, agriculture was a thriving industry in Peru. During this civil war, the greater part of the slaves were turned into soldiers; and once they had tasted the cup of military idleness and town life, they were incapable of returning to a country life and agricultural work. The cotton, sugar-cane, and vine estates, which constituted the agricultural wealth of the nation, were nearly abandoned, thus causing great losses. Each new citizen considered himself equal to his late master, and used the freedom which law had granted him in a most injudicious manner. As if this were not sufficient, Providence willed it that about that time Peruvian guano should be brought to the notice of Europe, and the suddenness of the springing up of this new and extraordinary source of wealth was the cause of the complete neglect of all agricultural interests in Peru. The nigger soon degenerated completely; country life had no longer any attractions for him and his, he yearned after the pursuits of the whites, he learned trades and even professions, and lived in the populated centres, leading, in most cases, a vagabond life; as a soldier he was a perpetual source of trouble and danger to the Government, the *pronunciamentos* having generally their origin from among the coloured troops.

When the agriculturists of Peru found themselves in such a sad plight, they considered what had best be done in order to save the country from becoming less and less productive, through the want of proper cultivation and care, and they, therefore, sought aid from the Government and implored for labourers. The Indian was entirely unfit for such work on the valleys of the coast, where the principal estates and farms were situated. The black and his cross breeds could not be induced to return to a life which reminded them of slavery; and so there was really nobody to do the work. It was then that immigration for agricultural purposes was first thought of, and the first idea was to get Europeans, but having failed to get sufficient supply of these, Chinese labourers, which had proved successful in other countries, were got instead. From 1856 until 1873, if my memory fails me not, whole shiploads of Celestials arrived yearly in Peru. At first very few were forthcoming, but, between 1869 and 1873, their numbers greatly increased, and there were as many as 13,000 imported in one year. These labourers helped in a great measure to revive the agricultural interests of the land; they were contracted for a period of eight years, during which time they were obliged to work for their employer, after which they were free to dispose of their labour. As a result of the impulse which agriculture received at the time, it is well to note that in 1870 Peru exported to this country 251 tons of raw sugar. In 1873 this quantity had grown into 15,950 tons, in 1875 into 50,000, and in 1879 into 71,400 tons. This was the year in which the war with Chile broke out, and, as a sequence to the misfortunes which befell the country, the exports of this most flourishing industry naturally fell in 1880 to 49,503 tons, and in 1884 to 26,565 tons. Since then a favourable reaction commenced to set in, the exports of sugar during each of the last two years to this country having averaged 42,500 tons.

Notwithstanding the immigration of Chinese

labourers, the Government have ever been trying to obtain a good and constant supply of Europeans, and towards this, several laws have been passed by Congress, and now and again contracts have been entered upon with different companies and persons for the introduction of European labourers into the eastern regions of Peru. A few colonies or settlements have from time to time been established within the territory composed of Germans and Italians; but, for the most part, the Europeans who have gone to Peru in order to seek a living, have given themselves more to trade than to agricultural pursuits, so really Peru, in this respect, may be said to still present an entirely new field for European enterprise.

The Sierra which, as I have said, is mainly dependent on the mining industry for the support of its inhabitants, like the coast, requires the aid of foreign capital, in order to achieve that development which its extraordinary mineral wealth demands.

The aboriginal who inhabits this part of the country is of a stolid nature. He dislikes agricultural work, which is generally attended to by his wife and female portion of the family, while he toils at the mines. It must be borne in mind that, as the Spaniards obliged all the Indians and their families to slave at the mines they have become accustomed to this kind of work; and so every *serrano* is, by instinct, a miner. He is, as a rule, very quick at learning all practical knowledge proper to his vocation; and, now that the Government have established miners' training schools in all the principal mining districts, he is developing a great and natural taste for skilled work. If that horrid *guarapo*, made from the juice of the sugar-cane, could be banished from the mining centres, in spite of the many drawbacks which have, since time immemorial, served to degenerate the descendants of a once powerful and civilised race, the *serrano* could yet be made an important factor in the greater development of his country. Unfortunately, the use and abuse of this stuff is ever on the increase; and, while its manufacture enriches a good many cane growers and distillers, its effects are fastly ruining a large section of the population. Perhaps, when the country, and its many other resources, are properly worked, new industries will spring up, more thriving, and decidedly more honourable, than the one which, as a Peruvian, I have to deplore, on account of its pernicious effects.

The greater part of the land in this region is owned by the natives themselves. Their wives till the ground, and grow maize, yucca, potato, and other indigenous plants and roots on which they mainly live. It is due to these great facilities of existence which they have, that the *serranos* are so careless of everything and so little ambitious; but it is to be hoped that, with the spreading of education and the bringing of these regions into closer contact with the commercial and industrial centres where the whites abound, that a change will soon take place beneficial to them.

At present, the number of mines which are being worked in Peru are comparatively few, when compared with the numbers during the Spanish domination. At that time, every available man and woman was sent to work at the mines. Since the War of Independence, the mining industry of Peru has suffered a great deal, and when the guano fever set in, hardly anybody thought of that which had made famous the name of Peru.

To-day, the same as in the agricultural interests, there is a reaction in favour of mining, and every year this industry receives new life and vigour. Its final development will depend on the interest which it may attract from the foreign capitalist and speculator.

The trasandine region, or Montana, where everything is exuberant, and where the hand of industry has not yet commercially developed the products of nature, is beyond dispute one of the most favoured fields for European enterprise. It is to this virgin region where I would convey you in imagination. Just fancy, for one instant, a region where grow in luxuriance, such valuable products as tobacco, sugar-cane, rubber, cotton, coffee, cocoa, vanilla, sarsaparilla, copaiba, the vine, oranges and other fruits, herbs and plants, both medicinal and oleaginous, timber and wood of every description; where the rivers are navigable, and on the banks of which some of the richest gold, and diamond, and emerald, and ruby fields are to be found. If this does not come to the expectation of the "El dorado," or does not realise as near as possible the tales of the "Arabian Nights," I do not know what does. And yet this is not a myth, neither is it the dream of a writer of fiction. Mr. Louis Wolff, a German engineer, who has only last year been exploring the valley of the Peruvian Amazon, says that it is his opinion that the gold washings of the Maranon and other rivers, if worked by the hydraulic system, would yield very great quantities of the precious metal. He urges that the Peruvian Government should send a

scientific expedition to the River Santiago, in order to make a proper survey of these treasures.

Many other Europeans and Peruvians, who have visited that part of the country, speak of its extraordinary wealth; and all who have been there feel surprised that it should not have attained a greater prosperity already.

The Government of Peru, fully convinced of the importance of this region, appointed a Special Commission to report upon it. Their report, which is a most elaborate one, and which does honour to the Commissioners, contains many valuable details with respect not only to the resources of the region, but with respect to its many requirements. Among other innovations which they recommend, perhaps the establishment of an Agricultural College and of a Bank of Agriculture deserve the most attention, as they would both be the best means of furthering the plans of the Government. The port of Iquitos, on the Amazon, from whence the products of this region are brought to Europe, carries on a very active and increasing trade with the outer world, and is called upon to be, at a not distant period, a very flourishing port.

Of the trade of Peru through the Amazon very little is known in this country, for the simple reason that all the Peruvian products exported, specially rubber, sarsaparilla, ivory-nuts, tobacco, and copaiba, are generally classified among the exports from Brazil. The steamers which navigate the River Amazon and its principal affluents are all Brazilian, and at the Brazilian port of Para these exports are transferred to the larger steamers, which cross the Atlantic and convey them to Europe. In view of this, the Peruvian Government have been authorised to offer a subsidy of $12,000 per annum to any steamship company which would undertake to run a regular line of steamers between the Peruvian rivers and the European ports.

As an item to any who may wish to study such a scheme, I will point out that the annual exportations from Iquitos amount to about 1,000,000 kilogrammes, while the value of imports represent about 1,000,000 soles silver. Besides the rubber trade, there is every facility for the carrying on of a large business in timber and cabinet woods. And from what I learn from this region, I consider that the erection of proper and modern sawing mills would prove a highly profitable venture.

I trust that I have been able to prove to you that immigration on a large scale into the interior of Peru would be the means of opening up a very rich country. That this is commercially practicable and profitable there is not the least doubt, as the products indigenous to the region, and those which can be cultivated, are of such value, and of every day increasing demand in the European markets, as to ensure the success of the enterprise; whilst the mineral wealth is next to inexhaustible, and the pasture lands so extensive, that any amount of cattle and domestic animals may be raised. I take it that you are all aware that, since the conversion of the old Peruvian external debt, the Peruvian Corporation, which was formed in order to take over the several concessions which Peru made to the bondholders, has sent several Commissions to Peru, with a view of studying the agricultural resources of the country, for the purposes of establishing European settlements or colonies on the large tracks of land which have been ceded to them by the Peruvian Government.

Some of these Commissions have now returned to England, and reported upon the country they have visited; and I am glad to see that they, more or less, endorse all my views on Peru as a field for enterprise. It is their opinion that the country is admirably suited for European immigration; and Mr. Clark, of the Royal Botanical Gardens of Ceylon, on this subject, says:—"With a climate of such salubrity and adaptability to a European settlement; a soil of exceptionable fertility; an immunity from most of the parasitical plant pests; the tropical products found, with an adaptability to the introduction of other economic plants, which have proved so important to the development of other countries; together with the opening up of the country, by means of improved transit, I have every confidence in the future prosperity of tropical Peru." It is, therefore, to this region that the European should go; and, by developing this part of the country, he would carry prosperity to the country at large. The railways already constructed, those in construction, as likewise those under survey, will all help to attain this end. These lines will place the Montana regions and their great arable lands in direct communication with the mining centres and with the coast. The interchange of products will give life to many new industries; population will be on the increase; fields of cultivation will extend; and, by the waterways of eastern Peru, and, by the Pacific, from its western shore, will be brought to

Europe the great and varied products of that country, whose name during centuries has been a by-word for riches. But whilst, in bygone days, such a name only referred to the mineral kingdom, in the near future it shall also refer to the agricultural wealth, which, above everything else, constitutes the life of a nation; a wealth on which it can well repose, and, by so doing, dedicate its newly-acquired energies to the further development of its other many resources.

I am not too sanguine by nature, and have been more of a pessimist than an optimist as a rule, in judgments and calculations, but I must confess that within the last two years I have grown more confident of my country's future; and I look upon you, the English nation, as the restorers of our former prosperity. Notwithstanding our financial default, you still come to our succour, and tend us a helping hand in the moment of need, and with that great energy so characteristic of your race, and which has expanded the limits of this little island until nothing can compare with it on the face of the globe, you now carry the standard of commerce and enterprise into the very heart of the old Inca empire, thereby serving the aims of civilisation.

Well, you may be certain that we all feel quite grateful for this, and that it is our desire to help you in the carrying out of such a grandiose enterprise.

In the foregoing paragraph I say that we mean to be grateful, and that it is our desire to help the British public in carrying out their schemes with respect to the development of our country. In order to do this, the Government have passed through Congress many most beneficial laws for the promotion of mining and agricultural pursuits. Education, which I may consider as the most powerful auxiliary of progress, and the main lever for raising a nation's social standard, meets with every support at the hands of the present administration. To-day, in Peru, besides the Government, municipal and private schools, which are kept up throughout the whole country, there are special establishments supported by the Government, where people of both sexes are taught some craft or other; schools of arts and sciences are being organised in different parts of the territory, and as I have already mentioned, there are good mining and engineering colleges, and schools for *capatazes*, overseers. A central agricultural college is already under consideration, and it is intended that in the agricultural districts special schools for the promotion of agricultural knowledge shall be established.

Import duties on machinery for agricultural, industrial, or mining purposes have been abolished; tools and implements for the same purposes are free, and so are many of the principal articles which serve for the promotion of industry.

Roads and means of communication are being established in different districts so as to bring the far off regions into closer and easier contact with the commercial or industrial centres. Telegraphic communication is fast extending throughout the country, and the navigation of the rivers of the interior is receiving the special attention of the Government. Already the road from Tarma to the tropical forests of Chanchamayo places Lima within 36 hours of that rich portion of our territory. While the roads to La Merced, San Luis de Shuaro, and to the banks of the Pichis and Paucartambo, bring the Montana within easy access of Lima, and open an interoceanic communication from the Atlantic through the Amazon and its affluents, and overland to the Pacific.

Nearly all the railways of Peru are in the hands of the Peruvian Corporation, Limited, and the extension work on some of the more important lines is being carried on with great energy.

The economical condition of the country is progressing, slowly but surely, as a glance at these figures will prove. In 1888 the revenue derived from Customs duties amounted to \$4,361,304·37, in 1889 to \$4,748,790·32, in 1890 to \$5,698,906·38, an increase of \$950,116·60 over 1889, and \$1,337,602·1 over 1888. The totals for last year are not yet to hand, but by comparison with the first six months of 1890 they show again a decided improvement for 1891. Other sources of revenue such as taxes, post and telegraphs, stamped paper, &c., have also been on the increase. The estimates for the current year of 1892 show a revenue of \$7,103,887·64 and \$6,012,617·10 for expenditure, leaving \$1,091,806·04 to meet possible contingencies and a paper superavit of \$708·84. The estimates do not include the special revenues applied to special services, such as are derived from the leasing of the tobacco, opium, and alcohol monopolies, the mining royalties, and all municipal duties and contributions, all of which represent over \$500,000. Peru has to-day no external debt, her internal indebtedness amounting to about £500,000.

The banking system of Peru is carried on by

the Banco del Callao, which has branch offices in several of the principal towns, the London Bank of Mexico and South America, and the Banco Italiano. There is no paper currency at present in the country, the silver sol, the value of which fluctuates according to rate of exchange and to the price of silver, being the standard coin of the country. It is a large piece of silver of the size of a double florin. The Banco del Callao issues a sort of "token" to bearer which circulates freely in the country.

I think that Peru requires a privileged Bank of Issue with a special charter, on the lines of that of the Bank of England, and I am confident that if a group of English bankers of repute were to make an offer to the Government to establish such a bank, the thing would be immediately taken up and studied in Peru, as everyone feels the necessity of such an establishment; more especially the agriculturists and miners, who are in sore need of capital in order to increase their productions. It is true that the banks, specially the Banco del Callao, do advance money on mortgages of real estate; but this is done at a high rate of interest, and for comparatively small sums. The Lima Mint, which is as fine a one as is found in South America, during 1891 turned 1,466 silver bars (the production of native mines), weighing 73,469,230 kilogrammes, into coin, the value of which was $3,100,201·67 in Peruvian currency, about half a million stirling.

Peru being a producing country, and its principal and staple products having a ready market in the European industrial countries, it is not to be wondered that, from a manufacturing point of view, the country should be still backward. Thus it is that, notwithstanding the fact that it produces the best cotton and wool in existence, it imports yearly for the value of about $3,000,000 of cotton goods, and $2,000,000 of woollen goods; while the exports of the raw materials amount to about $2,800,000 for cotton, and $3,500,000 for wool. These exports can be greatly increased; and no doubt will be according as the country progresses.

If the irrigation schemes are carried into effect, the coast valleys will soon produce a tenfold of what they do now; and as the quality of the Peruvian staples are reputed among the best in existence, ready markets would always be found for the greater production.

With respect to the Peruvian wool-bearing animals, I have only to say that their wool is of such a very superior quality, that it commands the highest prices in the market; unfortunately, this high price has caused as yet a limited demand, but I have every reason to believe that if the raising of these animals was to be carried on in the same economical and practical manner to be met with in the Australian sheep runs, the same success which this industry has obtained there would be obtained in Peru.

The textile industries of Peru are yet in their infancy. At present there is a manufactory of woollen goods in Lucre, in the Department of Cuzco. This manufactory dates since 1864, and has given a very large fortune to the owners, Messrs. Garmendia and Company, natives of Cuzco. Their idea was to manufacture the coarse woollen materials used by the native Indians of Peru and Bolivia, and also to supply the materials for the uniforms of the armies of both countries. This they have fully obtained, and there is an ever-increasing demand for their goods, both in the South of Peru as well as in the Bolivian markets.

As the estate of Lucre is situated in one of the best and most thickly populated districts of Cuzco, and where the best qualities of wool-bearing animals abound, the goods manufactured there are far superior to any similar European goods, owing to the fact that at Lucre only the pick of the wools is used, and such as is not exported to Europe. During the year 1890, Messrs. Prado, Hnos, and Pena established a wool manufactory at Lima, which, since then, has given every satisfaction, both to that firm and the general public. The machinery was built by the Societé Anonyme Vervetoise, and is quite modern—"self-acting" spinning-machines, and other smaller machines, are of English make.

The Vitarte Cotton Mill, situated seven miles distant from Lima, in a cotton-growing district, was formerly the property of a Peruvian gentleman, who sold it last year to an English company—"the Peruvian Cotton Manufacturing Company, Limited." The original fitting consisted of 65 looms, producing 1,000,000 yards of cotton cloth per annum; and, since the English Company took over the property, and invested large sums in fitting up 103 new looms, and erecting the latest and most improved modern machinery, the output has risen to 2,500,000 yards per annum of cotton cloth, besides great quantities of cotton wicking, waste, duck, towels, table-

cloths, &c., &c. This mill is to-day as well equipped, and is as complete a concern as the best mill of a similar kind in this country. The demand for the Vitarte goods has always been in excess of the supply. The entire production is disposed of in Lima to local buyers as fast as it is turned out. Owing, as I have already pointed out, to the superior quality of the Peruvian staple, the goods manufactured at Vitarte are better and more adaptable to the native requirements; and thus it is that they always maintain their briskness, and that their demand is ever on the increase, notwithstanding the fluctuations of the market with respect to the imported article, which has to pay a comparatively heavy import duty of between 8 and 24 centavos per kilogramme.

The valleys of Ferrenafe, Chicama, Guadalupe, Santa, Supe, Canete, and the Lima district are, perhaps, amongst the most famous for the cultivation and production of the cane. In these valleys the estates are simply superb, and the greater part of them are fitted up with machinery of the latest and most modern type. The sugar industry in Peru has suffered to a very large extent, owing to the keen competition of beet sugar in the European markets, and the increased production of cane in other countries which has caused a considerable fall in prices. Then, again, the Peruvian producers have had to contend with scarcity of labour, limited water supplies, a long and protracted foreign war, which brought about a most serious financial crisis, the effects of which are felt even to day.

Notwithstanding these drawbacks, the sugar industry is still one of the most important in the country, and one which promises to increase if proper attention is paid it. As a proof of this, I may mention that the production, during 1891, has reached 67,000 tons, an increase of about 10,000 tons over the preceding year. Some of the estates are provided with every modern appliance, such as narrow-gauge railways for the carriage of the cane from the fields to the sugar-houses. During the last year an English company has bought over one of the estates in the Chicama Valley, and put up powerful machinery of the most modern description, of the well-known firm of Fawcett, Preston and Co. The sugar-houses and the different departments have been fitted up with electric light, so that work is now going on at full pressure day and night. Due to the impulse which the capital invested has given to this estate, there is every reason to believe that this year's output of sugar alone will exceed 6,000 tons. The success which this venture has obtained, I understand, has been the cause of some inquiry after the Peruvian sugar estates, and I should not be at all surprised to learn that several others are being bought over by English companies.

Another instance where the purchase of a going concern in Peru has proved profitable to investors, is the case of Messrs. Backus and Johnston's brewery in Lima. These gentlemen established, in 1880, a very large brewery in Lima in order to meet the ever increasing demand for a light laager-beer. In 1890 their concern, which was, at the time, a most prosperous business, was bought over by an English company, and as a result of the capital invested in the business, I may mention that to-day the production has been quadrupled, and that the supply quite equals the demand.

The foregoing will convey to you what can be done in such a country as Peru when capital is forthcoming.

Like these, there are other industries which might be taken up and developed, and also others, entirely new to the country, which might be introduced at a great profit to the investors.

In the mining industries Peru has likewise had to depend upon native capital, and although we can boast of several big fortunes made in the mines, and within the last twenty years, I must confess that, in a great measure, this industry has not returned to its former prosperity, due to the scarcity of available capital in the country for the proper development of such an expensive and speculative industry.

Within the last few years some English companies have taken over Peruvian mines, and I have not heard of the investors having had any reason for complaint.

Speaking of the mining industries, I may mention the concentrating and smelting works at Casapalca, in the rich mining district of Huarochiri. These works date since 1889, and their products consist of base bullion and copper *matte*.

The plant is most perfect, and consists of Freue-Venner concentrators, stamps, crushing mills, reverberatory furnaces, Bruckner furnaces, kilns, a 40-ton water-jacket furnace, a complete laboratory is attached to the establishment, and in every respect the work ranks among the first of its class in South America. Sixty tons of ore can be treated daily at the works.

In the other mining districts I think that establishments of this class would be paying concerns, and although there are other smelting and concentrating works in Peru, yet none are so perfect as those at Casapalca.

One of the drawbacks in Peru to all industries has been the excessive price of fuel. English and Australian coal costs about £3 a ton in Lima, while the price for Chilian and native coal varies between 30s. and 40s. the ton. But as I said before, that Peru might really be considered as nature's most favoured country, the discovery of vast petroleum fields in different parts of the country, and the application of the crude oil as fuel in lieu of coal, has completely altered such a state of affairs.

The existence of bitumen, pitch, and petroleum in Peru was proved many years ago, but as always happens in the case of rich countries, while Peru had guano and nitrate to live upon, nobody worried himself about gold, silver, or oil. To-day, things have changed, and so it is that everyone now looks for the natural and true sources of wealth, such as agriculture and the many known rich mines which exist all over the immense territory. Following on this it was only natural that the petroleum district of Peru should have been surveyed, and the result has been to prove that Peru, in the Department of Piura, alone possesses over 16,000 square miles of petroliferous soil. Such a discovery at a moment when coal keeps rising in price, and when petroleum is in greater and increasing demand, and is considered on all sides to be the destined fuel of the future, brought about something like a fever in the country, and a rush was made for the petroleum fields. In 1888, there were 23 claims registered; in 1889, 36; and in 1890, 97; and last year the number had risen to 613.

Since these discoveries, two English companies and two syndicates have already been formed in order to buy some of these properties. So at present these fields are being worked to some extent. The result has been that Peru will shortly consume entirely her own product, and that she will be in a condition to supply the whole South American markets as well as China and Australasia.

The pioneer works in Peru belong to an Italian gentleman, Signor Piaggio, who has at Zorritos 54 claims of 40,000 square metres each. At present 11 wells are being worked, and these supply sufficient oil for refining 6,000 cases per month. These works have fine machinery, and the property is well equipped and fitted up in every respect.

Of the English companies, the London and Pacific Petroleum Company, Limited, is for the present the one which has the first and largest establishment for refining petroleum and supplying oil fuel in the country. The company possesses some tank steamers, and has just started an experiment of introducing Peruvian kerosene into China, a venture which I hope may meet with every success. The following figures will give an idea of the progress which this industry is already making at Zorritos:—

EXPORTS.

	kilos.
(1889.)	
Crude oil	2,151,874
Kerosene	999,658
Lubricating clear oil	457,799
(1890.)	
Crude oil	2,324,219
Kerosene	1,199,161
Lubricating clear oil	1,115,677

and from Talara, where the London and Pacific Petroleum Company are established, the exports during 1890 consisted of 1,100 tons of crude oil in tanks, 46,589 cases of kerosene, and 4,000 barrels of lubricating fine oil.

The future of mineral oil, as a fuel, has advanced another step, perhaps its final one, since the recent important invention of Mr. Chenhall for solidifying the crude oil. If, as appears from the tests and experiments to which the petroleum in its new form has been subjected by some of your most trustworthy and experienced engineers and chemical analysts, the problem of solidification has been solved, then indeed must Peru be congratulated on her extraordinary good luck, which will give the country a most valuable industry, one which I may describe as the parent industry to nearly all others. With fuel of a superior quality, advantageously situated for exportation, capital will not then tarry to come to the country, and give impulse and life to new and and at present latent industries. What strides in the way of progress a country thus favoured will be able to make, I leave to you to consider.

I must now bring my reading to an end, leaving many and important subjects for other and better hands than mine. But, before I sit down, I beg to call your attention to one point, which I am sure will interest you, even if commerce and industrial enterprise be not among the pursuits or callings of all. I refer to the action of the Government of the United

States of America, in promoting the establishment of a Bureau of Information of the Latin-American Republics at Washington; and, I ask, why could not a similar thing be attempted here in this great metropolis, where, undoubtedly, the commercial, industrial, and financial interests of those countries are rooted, and from whence the capital, which gives life and vigour to every enterprise, emanates?

Some time ago a friend of mine, Mr. L. Tamini, an Argentine gentleman, communicated to me a plan for establishing in the great city of London a Latin-American Chamber of Commerce and Bureau of Information. I endorsed his views; and, with the help of Messrs. Baille, Consul for Paraguay, and Mr. Mackinnon, Consul for Uruguay, we tried to give form to this splendid idea. The financial crisis of 1890, and the political and economical outlook in some of the most important sections of the South American continent, spoiled our labours, which, perhaps, did not meet with all the encouragement which they deserved from the public supposed to be interested in Latin-American affairs; this, I believe, in sympathy to the abnormal situation which the city experienced at the time. However, be the reason and cause what it may, the fact is that we have not been able to carry out our idea on the lines proposed, and therefore have had to content ourselves—at least, for the time being—with an embryo Chamber of Commerce. This exists, perhaps, more in our imagination than in reality, but it nevertheless exists, and I think that, by a little propping here and raising there, it might be made the very bureau which I consider most important should exist in such a centre as London.

The average Latin-American, who comes to this country on business, finds himself lost in London, as he ignores the language, and, above all, the special manner in which English business and transactions are conducted. If he does not fall into the clutches of men of straw he may consider himself very lucky, but the chances are ten to one that, wishing to avoid them, he gets caught in their meshes at some boarding-house where he is probably staying, in order to learn or practice, as the case may be, English. The result is that his business is hawked about, and as the person in charge of it is of very dubious standing, to put it mildly, it is naturally rejected, without the honours of a listening or of a reading. Meanwhile the confiding, but ignorant, would-be vendor is whiling away his time sight-seeing, and speculating on, when not actually living upon, his future gains. The months pass, and at last he is told that the times are bad; that money is tight or loose; that the state of his or of the neighbouring country is troubled; that the smash of such a firm in Honolulu, or any other place on the earth, has produced a financial crisis, and that there is no prospect whatever of doing business for the moment. After having spent more money than was necessary, the individual returns home to tell his friends and countrymen that there is no business possible in England; and thus, perhaps, a good concession or a good business is thrown over or buried in oblivion until another chance is given it.

The Bureau which I recommend, would be the rendezvous for all Latin-Americans in this city; thither they would go to discuss business and to meet the persons they should have made appointments with. As for the English portion of the public, they would be able to obtain from such a bureau all the information they should require without having to call upon the consuls at all hours, and get, perhaps, about one-tenth of what they expected.

That the proper organisation of such a chamber or bureau is useful, need not be pointed out to you, as it is to-day a universally acknowledged fact that it is through such institutions, and by their aid, that the spreading of commerce from nation to nation is carried on.

I must now apologise to you all for my very dry discourse, which I thank you for having listened so attentively to. I hope that I have impressed you with the importance of the country which I have so poorly and confusedly attempted to describe to you, and that it and you may derive some positive benefit from what has been put forward.

DISCUSSION.

The CHAIRMAN thought that the exhaustive paper to which they had just listened must have conveyed to them a great deal of information about Peru, a country in which Englishmen ought to be deeply interested, as England had a greater amount of trade and commerce with Peru than with any other country in the world. The paper embraced a number of subjects, such as the question of immigration, public works, including railways, products of the country, manufactures, and the navigation of the Amazon, as well as financial questions; and no doubt there were many present who would be glad to speak upon one or the other of these subjects. He hoped that some remarks would be forthcoming as to the formation of the Bureau of Information, to which reference had been made in the paper.

Sir ALFRED DENT thought the facts collected by Señor Pezet must carry a great deal of weight, seeing the important position he occupied in England as Consul-General for Peru. So long as Señor Pezet held that office, he felt confident that his country would be well served, and that those who came in contact with him would be well pleased. Amongst other subjects alluded to, was the interest which Englishmen had in Peru. That was perhaps more centralised now that a great company had been started in London, whose special business it was to work and develop all the railways and other properties which Peru had handed over to the bondholders, and to bring that enterprise into a good commercial position which would do credit to the Englishmen who undertook the work, and bring that success to Peru which the country so much needed. The railways were peculiarly interesting to those who had time to study them, seeing that many hundred thousands of pounds sterling had been spent upon them. The Southern Railway crossed the Andes at a great elevation, when it went down to Lake Titicaca, which was some 13,000 feet above the level of the sea, 150 miles long and 40 miles wide in many parts. The lake was navigated by two small steamers, and a third steamer of much larger capacity, which had recently been built upon the Clyde, would shortly be added. This steamer, which is 170 feet long, will shortly be shipped to Mollendo, and having been taken over the Andes and through the tunnels, would be put together on the border of the lake at Puno. It is proposed, by means of this steamer, to navigate the lake to the mouth of the river Desaquedero at the further end, in order to open up the mineral districts; and in time the southern railway would probably be extended from that point to La Paz, the capital of Bolivia, thus increasing the lake traffic. The Central Railway, further north, commences at Callao and Lima, crosses the Cordilleras at an elevation much higher than Mont Blanc. It afterwards dives down in the direction of the tributaries of the Amazon into a most fertile agricultural country, and it is the forests of this country that the well-known Ceylon planters, Mr. Ross, Mr. Sinclair, and Mr. Clarke, have been exploring lately on behalf of the Peruvian Corporation. They all give a glowing description of the soil and district from a planter's point of view; and it is hoped that several planting industries will soon be started there under the management of Ceylon men. The two difficulties to be dealt with are that of labour and transport, though the latter would be overcome no doubt as soon as the railways were extended. With regard to the labour, they were told that there were a good many natives in the interior of Peru, but it was a question how far that labour was available to meet the wishes and wants of English planters. They hoped to introduce foreign labour—Chinese and others—and they looked to the Peruvian authorities to do all they could to assist them in this direction. The Chinese were a very industrious class, and if properly treated, proved to be the best labourers in the world for the tropical regions. As regarded petroleum, which was being extracted by one or two companies, he might say that petroleum was being largely used in the form of liquid fuel on the railways, nearly all the locomotives having been converted so that they could burn refuse petroleum, thus effecting a saving of some 40 or 50 per cent. They had been told that English coal cost £3 a ton in Lima, but he was glad to say they could get it for considerably less than that now, though in many of the mining districts the miners would willingly pay £12 a ton for coal. Speaking from an agricultural point of view, from all accounts to hand it was clear that the soil was of a very rich kind, and the climate also was most enviable. At Lima the temperature was from 60° to 80°, which was the most perfect climate to live in. Fevers were comparatively unknown there. Peru had one advantage over many of the South American States, viz., that its paper currency had practically disappeared, wages and the like being paid in coin (Peruvian dollars). Señor Pezet had rather led the meeting to believe that the question of solidifying petroleum had been solved, but perhaps the Society of Arts would have a word to say upon that question later on, as many seemed to doubt whether this question had been absolutely settled. No doubt if the refuse petroleum could be solidified, when it might be easily carried, and afterwards liquified so as to be used on board ship, it would do a great deal towards supplanting coal. He was strongly in favour of the establishment of a Bureau in this country at which information could be obtained by those who wished to seek their fortunes in South American colonies. The first qualification necessary for that was a knowledge of the Spanish language. It had been the fashion, of late years, to learn German, though he could not quite see the use of this language to a man who had to make his way in the world. It might be useful for academic purposes, but it was not nearly as useful a language as Spanish in the Colonies of the New World. Of course, this was a subject upon which opinions might differ.

Colonel HARRIS said, as an old resident in Peru for twenty years, and one who had known Señor Pezet from a child, he could not refrain from making a few remarks upon the excellent paper which had been read. He could endorse nearly the whole of it, having travelled from north to south and east to west in Peru. He concurred in the statement as to the natural riches of the nation. It was almost like a fairy tale; but Señor Pezet had only touched the fringe of the natural sources of Peru. Time would prove, as railways were opened and immigration was poured into the country, that all he had stated was correct. As one of the pioneers of the mining industry, he did not think that enough had been said of the wonderful gold sources of Peru. In Caraybaya

and Sandia, which were only four days' journey from a railway, the country teemed with gold, both in the alluvial and in mines; and it was snrprising that English capitalists should go thousands of miles to the wilds of Africa, when they could go comfortably in a steamer to Mollendo, and thus get within four days' journey of one of the richest deposits of gold in the world. The finest coffee was also grown in Peru; in fact, the quality was so much appreciated that very little of it was ever sent away. His son, who had a large interest in the northern part of Peru, was at the present moment sinking wells for petroleum. One of the companies there had a 4-inch hole from which a spout of oil rose 25 feet above the surface. This would give some idea of the quantity of oil there. He did not believe that the supply would ever be exhausted. Many experts thought that the deposit of oil was far greater and much superior to that of Pennsylvania or Baku. He disagreed with Señor Pezet entirely on the question of solidifying petroleum. This had been tried in Russia by means of a soap, which turned the petroleum into a kind of vaseline. The cost of doing this was from £1 to 25s. a ton, which, in itself, was quite sufficient to prevent the process from being carried out successfully. There would always be an immense demand for petroleum on the coast. At the present moment the Pacific Steam Navigation Company were using 100,000 tons of coal per year, but if they could use petroleum, and take in a cargo within two or three hours at their very door, an enormous saving would be effected. He thought the time was not far distant when a large number of steamers would be supplied with petroleum fuel from this district.

Mr. G. E. CHURCH said he might safely endorse all that Señor Pezet had said with regard to the vast resources of Peru. He was one of those who believed that Peru had now commenced its true era of national development, and his reasons for so thinking were these. From the time of the conquest, from 1525, up to the war of independence, Peru was under the rule of the viceroys. Everyone knew what that was, it was a rule of ruin and of the absolute depopulation of the country. The Spaniards built no roads; and the only two good buildings that they ever built were the cathedral and the mint. These they never repaired. Under Spanish rule, the Peruvians remained an illiterate race. After some years the Peruvians drove out the Spaniards, and then came the question what form of government should they adopt? The wildest republican theories were adopted, born of the teachings of the French Revolution; and, for 40 years, they cut each other's throats, until, finally, they acquired some stability. Then came a period when Europe wanted Peruvian guano—a period of prodigality and plunder. The natives did not develop the mining and agricultural wealth of the country; but everybody seemed to be related to everybody else who had an office under the Government, and so long as the guano lasted the period of prodigality and plunder went on riotously. Upon the guano becoming exhausted, nitrate took its place; but this having attracted the attention of Chili, the result was, that a war broke out in 1879—never mind under what pretext, though he fancied everyone knew that it was the nitrate fields. The reader of the paper spoke of this war as a misfortune to Peru, but he should characterise it as the turning point of her fortunes. It was the greatest blessing that could possibly have happened to her, as it made everybody poor, and they could not live any longer on the Government. When Chili had taken the nitrate fields, and left Peru stripped of everything, they were about as reduced as any nation could possibly be. They had to commence to wear out their old clothes, as they had nothing to exchange for new ones. This period continued for about six or eight years, from 1882 to 1889. Slowly coming to their senses, they began to comprehend that the real wealth of the country consisted in mining and agriculture. It was for this reason that he contended Peru had commenced her regeneration by going to work to develop her vast mineral and agricultural resources. But then came the crucial point, how were they going to do this on a grand scale without increased population? They had very profitably turned over the railways to the Peruvian Corporation, which would contribute very largely to the regeneration that everyone desired. That brought him to the question of immigration. Immigrants were strange people; the immigrant who was good for one country might be very inferior for another. You had to take the native population into consideration. In Peru the mountain people did not like to go to the lowlands, and the lowland people did not like to go to the mountains. They did not thrive by the change. You had to seek a class of immigration for Peru having regard to the considerations of the place where you could put them, and the products of the district to be cultivated. The reader of the paper had spoken of the lazy nigger, but negroes were a great deal like white men, they would not work unless obliged to. They were very similar to other races in this respect; it depended a great deal on how you treated them. Numberless laws might be made, but this would not get immigrants. If you got one immigrant you would not get two, unless the first wrote back, and said he liked the country and the way he was treated. The great fault with Peru was that the immigrant was badgered about by all the little petty authorities, the result being that life was made miserable to him; and he would write back to his friends, and say, "Don't come here." He told the Prime Minister, when asked, a few years ago, at Rio de Janeiro, as to why immigration could not be got in Brazil, that it was because of the bad way the immigrants were treated, they being then classed the same, socially, as slaves. Until

labour was respected, and considered honourable, they would never get immigration. He hoped he would be excused for being perfectly frank about this subject. He was a great admirer and had firm faith in the future of Peru, believing that it had got through its babyhood, and would become a grand country.

Mr. A. Ross said, as one of the Commissioners who had been sent out by the Peruvian Corporation to examine the agricultural resources of the country, he might say that he thought the reader of the paper had rather underestimated the riches of the country, both mineral and agricultural. What was required to open out the country was the introduction of labour from other places. The climate of Lima, at the time of our arrival in Peru, in June last year, was very much the same as that of London during summer, with the exception that it seldom rained. By means of irrigation the coast could be turned into a vast sugar plantation. In fact all along the central part of Peru it was suitable for European immigration. The railways were being rapidly extended in the interior, and shortly an interoceanic communication would be open from the Atlantic through the Amazon and overland to the Pacific.

Mr. J. Ferguson (Ceylon) said interest in Peru was not confined to England. Those living in the east of India and Ceylon had a special interest in Peru, because of one of the greatest blessings that had been conferred upon the human race in Southern Asia, viz., the introduction of the cinchona plant. A few plants were brought to Bombay, in 1861, by Mr. Markham, and the cultivation was commenced by Government on the Nilgiris and in the Hakgala-gardens, Ceylon, the result being that the cultivation of that product in the eastern world had increased to such an extent that the price of quinine, which at that time was 16s. an ounce, had now been reduced to 9d. an ounce. What that meant to the lives of millions in India and China, the European world had but little conception. When coffee failed in Ceylon, their planters went in for cinchona, and for some years this was a profitable investment, until the exports reached nearly 16,000,000 lbs. of bark in 1887, and since then the price tumbled down so enormously that the ordinary cinchona trees remaining in Ceylon became not much more valuable than the weeds on a plantation. Our planters had next to take to tea. But there was some danger that tea in India and Ceylon might follow very much in the wake of cinchona through over-production in proportion to demand. In ten years the exports from Ceylon alone had risen from almost nothing to 68,000,000 lb., and there was the prospect ere long of their reaching 100,000,000 lb. annually. Now, while warning them against tea, on the other hand he would remind intending planters in Peru that coffee had failed in India, Ceylon, and Java. The eastern world now did not give one-fourth the quantity of coffee it did a few years ago, and Ceylon planters in Brazil represented that it had got to the top of the tide with regard to coffee. Therefore what they had heard that evening of coffee doing so well in Peru as well as cacao, gave the greatest possible encouragement to capitalists and planters to look to Eastern Peru as a future place of supply for these valuable products. He said this because he had had the pleasure of reading Mr. Clark's report, as well as the unpublished report by Messrs. Ross and Sinclair. The opinion of these latter two practical coffee and cacao planters would be accepted in the eastern planting world, when their report appeared, as about the best opinions the Peruvian Corporation could possibly have with regard to tropical products in Peru. Ceylon continued to be the best school in the world for the training of tropical agriculturists, and the Ceylon planters would read of the prospect in Peru with the greatest possible interest, and as the hill country of their little island might be getting rather overcrowded, some of their planters would no doubt begin to turn their attention to the west, and perhaps, ere long, make their way to the Amazonian regions of Peru.

Mr. J. I. Watts said, having visited and taken a great interest in Peru, he could endorse all that Mr. Pezet had said with regard to agriculture. The picture had not been overdrawn in the slightest. The cows raised upon the farms in Peru would not disgrace any agricultural show; their yield of milk being also large and of the richest quality. The results obtained in this direction were no doubt largely due to the richness of the pastures, and to the splendid climate. He could not say so much for the sheep, although he had seen some very fine specimens there. In 1876, he crossed Peruvian rams with Dorset sheep, the result of which had far exceeded his expectations, and the breed of sheep was now being considerably improved. He considered there was a very great future for Peru, both from its vast agricultural and its mineral resources.

The Chairman, in proposing a vote of thanks to the reader of the paper, said he thought there was a peculiar fitness in their having received this information from Señor Pezet; there was an official fitness, and there was an hereditary fitness. Señor Pezet's great grandfather was one of the very first men in Peru who raised the cry of freedom, and he was a martyr to that noble cause. Señor Pezet's grandfather, whose acquaintance he had the pleasure of making in years now long gone by, was one of the most accomplished Presidents of Peru, and the one who introduced the decimal system into that country. Señor Pezet himself had served his country in war, and had done good service in peace; in fact, he was doing most excellent service to his country at the present time

in England in his official capacity as Consul-General. For these reasons he had great pleasure in congratulating the meeting upon the valuable paper which had been read; and he might also congratulate Señor Pezet on the interesting discussion which had taken place. He begged to propose a cordial vote of thanks to the author of the paper.

The vote of thanks having been carried,

Mr. PEZET, in returning thanks, said if he had touched upon all the points which had been referred to in the discussion, the paper would have been double the length it was. If any one required further information upon any subject he should be happy at any time to give it. He believed that Peru had now turned over a new leaf. Though he could not quite accept everything which Mr. Church had said, at the same time he accepted the general points.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 23, 1892; Sir FREDERICK J. BRAMWELL, Bart., D.C.L., F.R.S. (Deputy-Chairman of the Council), in the chair.

The following candidates were proposed for election as members of the Society:—

Kirby, Frederick Hall, Union Club, Trafalgar-square, W.C.
Meachan, Charles S., Brewery-house, Earl-street, Maidstone, Kent.

The following candidates were balloted for and duly elected members of the Society:—

Chase, George B., 234, Beacon-street, Boston, Mass., U.S.A.
Formoy, James Arthur, Lestelle, Forest-hill, S.E.
Goodridge, Captain John James Lewis, Portswood, Southampton, Hampshire.
Mallet, Robert Trefusis, 1, Philbeach-gardens, South Kensington, S.W.
Wye, Thomas Henry, Brooklands, Leytonstone, Essex.

The paper read was—

THE MANUFACTURE AND INDUSTRIAL APPLICATIONS OF FLEXIBLE TUBING.

By GILBERT R. REDGRAVE, Assoc.Inst.C.E.

The history of the extensive use of flexible tubing seems to be most closely related to that of india-rubber, which substance, in its various forms, has furnished the principal descriptions of flexible tubing at present in the market. Previous to the discovery of caoutchouc, the name by which the raw rubber was at first known, and which was the South American Indian word, denoting the india-rubber tree—the *Siphonia elastica*—the different kinds of flexible tubing seem to have been prepared either from strips of leather fastened together by means of copper or metal rivets, or by winding thin bands of linen or other fabrics, soaked in gums or varnishes, round a mandrel or core. The use of tubes or hose, woven in a circular form without a seam, is an invention of much later date, and would appear to belong to T. B. Brown, who patented a seamless hose in 1849, though he seems to have been anticipated by Hegner as long ago as 1792.

The commercial employment of india-rubber —the inspissated or coagulated juice of several varieties of trees—dates back to the early years of the present century, but it scarcely attained to any real importance until Hancock's spreading process, which was made known in 1837, or the perhaps even more important invention of the process of vulcanising rubber, or causing it to combine with a certain percentage of sulphur, which was patented by Hancock in 1843. Another epoch-making event in the history of this material was the plan of cold curing, which involves the use of carbon bisulphide, discovered by Parkes, in 1846. It is scarcely necessary that I should trouble you now with the history of india-rubber manufacture, for this matter has been dealt with on previous occasions in this room, and the various processes were fully described by Mr. Bolas, in a series of Cantor lectures, in 1880. I may, however, very briefly allude to that branch of the manufacture connected with the production of tubing of this material.

India-rubber tubing is manufactured by two distinct methods:—

1. By squeezing or squirting the prepared semi-fluid rubber through a die or orifice; and

2. By the mechanical jointing of hollow cylinders of sheet rubber.

In a machine, invented by Mr. Francis Shaw, all the requisite ingredients are conveyed, by means of a hopper, into a horizontal cylinder, kept at the requisite temperature by a steam-jacket. In the interior of this cylinder the rubber is compressed by the action of a piston or plunger, and is forced out at the end through a die or nozzle of any required section. The tube, as it emerges, is coated with powdered steatite, and is packed in a layer of this material, in order that it may be

vulcanised, by means of dry heat, in a vulcanising chamber. It is then ready for the market.

In the second process, india-rubber is spread upon sized cloth, and stripped into sheets. It is then cut into strips of the right width, to furnish a tube of the requisite diameter, when bent round into a cylindrical form. Next, the cut edges are bevelled, which causes the surfaces to unite more perfectly when brought into contact with each other. The strips are then passed through a heated die, being previously doubled into the form of a cylinder. In their passage through the die—which is of the requisite size to form the tubing—the bevelled edges are compressed together and made to unite. In this way a tube is produced, which, as it issues, is coated, as before described, with steatite powder, and subsequently vulcanised.

The red-coloured rubber tubing, which is considered by some to be more durable than the grey, is made by employing orange-red coloured antimony pentasulphide with the "mixing"—the technical name for the prepared ingredients—and the superior strength of this rubber does not in any way depend upon the colouring matter, but must be due to better quality in the mixing.

The production of a flexible tube or pipe of metal has long been a desideratum, and the subject has not escaped the thoughtful attention of inventors, as a brief scrutiny of the records of the Patent-office will not fail to show. I cannot hope on the present occasion to bring under your notice a tithe of these inventions. I may, however, point out that a favourite plan of overcoming the difficulty involves the use of coiled wire, either alone in several thicknesses or in conjunction with a metal strip of some other section. I have some specimens here of some of these varieties of tubing; thus under an ingenious plan of American origin, tubing is produced by the combination of a wire and a triangular fillet. It will be readily understood that a tube constructed in this way on the helical principle would be possessed of considerable strength, though I should be inclined to doubt its tightness, owing to the small extent of metallic surface in contact, while the relative weight of metal required per foot of tube is more than treble that of the invention I shall hereafter describe.

Another method of building up a flexible tube is on what has been termed the accordion system, wherein numerous thin concave discs of metal are soldered together alternately, at their inner and outer edges. This really constitutes a series of rings, or a tube is produced on what is termed the annular system. Such a tube is a very flexible, but not a very strong one, and this cannot fail to be of course a relatively expensive plan of obtaining the object in view. Flexible tubes have also been produced from super-imposed coils of channel and half-round sections of corrugated metal, having a packing of india-rubber at their junctions. The section of this kind of tubing is very similar to that first employed in the invention of Mons. Levavasseur. By binding india-rubber tubing externally with a spiral coil of wire, and introducing within the rubber tube a lining of coiled wire, the different kinds of so-called "sphincter-grip armoured hose" are produced.

A moment's consideration of the difficulties involved in the manufacture of a flexible metallic tube will serve to indicate not only the direction in which the question has to be approached, but also the readiest method by which the task may be accomplished. It is clear that to obtain flexion the tube must be built up of a vast number of small moving parts, and that the degree of flexibility will, to a great extent, depend upon the relative size of these parts. If we contrive a joint, which permits of a certain amount of play, and this joint occurs at certain fixed intervals, the total extent of flexibility in a given length of tubing will be contingent upon the extreme amount of play at each joint, multiplied by the number of joints in such given length, assuming always, as we are bound to do in the case of a tube of metal, that the sections themselves are rigid. The movement or play must, therefore, in the case of a tube of metal, be provided at the joint. Now, a very brief study of the problem will further teach us that such a tube may best be formed from a continuous strip of metal spirally wound, as it would be impossible, or next to impossible, on the score of cost, to contrive a series of rings, securely jointed one within the other on the annular system, with movable joints, each of such rings being sufficiently narrow to ensure the due degree of flexibility in the tube.

For many purposes, it is true, where a very slight amount of flexibility is required, the provision for such play is secured by joints of the above-mentioned kind. Thus, for earthenware or stoneware pipes, which, as you are aware, have to be laid in trenches, and which, even with the utmost care in the laying, are liable to slight movements by settlement or displacement, a joint, known

after its inventor, Mr. Stanford, has been devised, in which the spigot end of the one pipe has a ring of pitch or composition, which fits into a faucet in the adjoining pipe similarly prepared. As will be evident, from the form of this joint, a small amount of displacement would not be fatal to it, while a rigid joint, formed of cement, or similar material, would be crushed by a very slight settlement. For the junction of metal pipes, which are laid in much longer sections, gene- of 9 or 12 feet in length, a very ingenious joint has been devised, which depends upon the elasticity of a ring of vulcanised india-rubber, resting in a groove on the spigot of the pipe, and rolling into the faucet, when the two pipes are forced together to make the joint. The tightness of this joint depends of course upon the soundness of the rubber; and, as I shall show that rubber used in this way is liable to deterioration and decay, we are bound to assume that this is not a joint of a permanently durable character.

All engineers are aware that it is no easy matter to produce an absolutely tight joint between two metal surfaces; and for this reason alone most of the earlier efforts to obtain a flexible metal tube were based on the use of some foreign substance to form a packing. This substance was generally a strip of india-rubber, and, for the reasons already given, the first flexible metal tubes could not be regarded as otherwise than imperfect from the point of view of durability.

As I have already pointed out, the problem of making a flexible tube of metal was found to depend upon the method of coiling a strip of metal in a spiral form round a mandrel or core in such a way that the continuous joint or seam between each coil of the helix was not only perfectly sound, but was also possessed of mobility. In tracing out the gradual steps by which this problem has been mastered, I shall have to bring before you the history of the so-called flexible metallic tubing, the invention of Mons. E. Levavasseur.

M. Levavasseur has given me the following brief account of the details of his discovery. Some twenty years ago, while engaged in the manufacture of jewellery, he produced bracelets and necklaces of thin laminæ of gold and silver, the original form of which was tubular; the tube being built up of strips of metal of two different sections, coiled one above the other. To accomplish this a flat channelled section is first employed, above which is wound a semicircular clip, serving to unite the channels together, and to form a complete tube. This pattern, either circular in section or flattened into an oval form by hydraulic pressure, was, for many years, in great request for necklaces of gold and silver, and M. Levavasseur was profitably employed in their manufacture under the terms of a patent which he had obtained for the invention. In time, he was able to produce necklets and other ornaments from coiled metal strips on the inter-locking principle, having an S section, where only one continuous strip is used, and the convolutions grip one into the other. While he was engaged in the manufacture of jewellery, he designed nearly all the different forms of corrugation now used for tubing.

It was not until about six years ago, when he was walking one day with his partner in a Paris thoroughfare, that the invention, in its present shape, took practical form. He saw the men engaged in cleansing the asphalte with that curious apparatus which is so frequently seen in Paris, but which I do not remember to have met with elsewhere, viz., short lengths of piping, carried on a pair of small wheels fore and aft, and joined together by copper-rivetted leather hose, to secure flexibility. M. Levavasseur remarked to his partner that this seemed a very unwieldy and cumbrous contrivance, unworthy of the 19th century, and he was surprised that something different was not introduced. His partner said that they used it in default of some better substitute, which had still to be provided. Said M. Levavasseur, "I could contrive something much better adapted for the purpose, and far lighter and more flexible." On being asked to explain, he said, "I should make an enlarged tube of the same kind as we use for the spiral necklaces, and insert a strip of india-rubber between each coil to make it water-tight." His partner saw at once the value of the notion, and it was forthwith patented, and has now been developed into the tubing I am able to bring under your notice this evening.

Starting with a simple ribbon of metal, which we will, in the first case, regard as perfectly flat, but capable of being coiled in a spiral form round a core, we should obtain a tube; but in order to obtain a cylindrical tube, we must assume the metal to undergo a certain amount of distortion, for the tendency of such a strip would be to take the form of a truncated cone. This fact may be familiarly illustrated by a strip of paper wound in the required manner to

form a spill, which, it is well known, tapers from the base upwards. A tube thus wound would obtain its flexibility by the sliding of one coil over the other; but the flexibility, in this case, would be very trifling, the coils would very readily be strained apart, and would be very liable to become clogged with grit and dirt. As a matter of fact, it would be quite impossible to produce in this manner, even with a strip of india-rubber inserted along the seam, a sound and tight flexible tube.

Starting then with the plain strip, it appears that means must be devised to form something superior to the simple lap-joint we have just investigated. The strip must, in fact, be corrugated, and in the first form of the invention the strip was corrugated by a similar process to that by which iron bars of various sections are drawn out in the rolling-mill. In the strip originally employed, the section somewhat resembled the form of a double channel, and the strands or coils of metal were hooked together and grasped between them a small strip of rubber. The tightness of this joint clearly depends upon the presence of this rubber, and the play or flexibility is contingent upon the amount of movement possible of the one hook within the other. When the tube of this description is bent, the tendency will be for the joints along the outer-edge of the curve to draw closer together and to bite more firmly on to the rubber strip; but, on the other hand, for the corresponding parts of the joints on the inner face of the curve to open out and relinquish their grasp of the rubber. It will be apparent from the section, that in tubes exposed to much flexure there will be a great strain on the rubber, and it was found, in practice, that this joint, though it gave great flexibility, rapidly caused the rubber strip to work out and deteriorate. Not only, therefore, was this particular form of tube defective, in that it relied mainly for its soundness upon a perishable substance—the rubber—but it also exposed that rubber to an undue amount of wear and tear.

In the next stage of the invention we find strips of a fresh section employed, more resembling the figure of 8, and giving a much more perfect interlock between each coil. In tubes constructed of this section there is less flexibility, perhaps, than in those of the double channel type, but the rubber is much more securely embedded, and the tendency of the latter to work out is greatly reduced. Moreover, it becomes impossible for the coils to be drawn apart even under very great pressure, and the disruption of the tube can only be effected by a force sufficient to split the metal strip. Several types of this interlocking section, which were in turn introduced and tested, are shown in my diagrams. Where the rubber is so placed that it is gripped by the double hook, it becomes possible to cut the rubber to pieces by frequent and violent bending of the tube, but several of these sections seem to have overcome entirely the tendency, on the one hand, of the rubber strip to work out, and on the other, of the different coils of the metal to draw apart. The rubber strip, though it conveys an element of weakness, may, under certain circumstances, be employed with advantage. For instance, in flexible tubes, where the contents are at very low pressures, as in the case of gas tubing, the rubber may safely be introduced; but where the tubes have to be steam-tight, and where the contents of the tube are under great pressure, it is convenient to dispense altogether with the rubber strip. While I am dealing with this part of the subject, I may mention that, when rubber is used in an iron or steel tube, it remains practically unchanged for considerable periods of time, but that when it is employed in a tube of copper or brass, it appears to undergo some chemical action, which leads to its ultimate conversion into a dark resinous compound, devoid of elastic properties. This altered form of the india-rubber, though it serves as an admirable packing between the surfaces of metal, and certainly improves the tightness of the tubing, deprives it almost entirely of its flexibility.

Dr. Burghardt has pointed out that this deterioration is due to the action of oxygen, which is in reality the great enemy of all kinds of rubber. Certain of the heavy coal-tar oils, and many oils of animal and vegetable origin, such as tallow oil, fish oil, olive oil, and cotton-seed oil, when brought into contact with india-rubber seem to set up the oxidising process with fatal rapidity. Copper oxide, in conjunction with oil, is a source of peculiar danger to caoutchouc, and in the tubing formed of copper the destructive action has been observed in less than a twelvemonth. For those purposes, therefore, where the use of a rubber strip is advisable, it is necessary to employ a protective coating of tin or some other metal on the surface of the copper to guard against this action. Rubber, when fully oxidised, becomes quite brittle, and is split up into two resinous substances, the one discovered by Spiller is soluble in alcohol, ether,

and carbon bisulphide; the other substance, the discovery of Dr. Burghardt, is not acted upon by those solvents. Oil, which is usually freely employed in the manufacture of tubing, can, in order to obviate this danger, in the case of copper or brass, be replaced by soap and water, or some other lubricant, and an increased amount of rubber may be inserted in the space between the metal coils, to make good the waste.

An attempt to employ a flatter and less violent curve will be seen in the diagrams of certain of the sections, for it is manifest that the toughness of the metal must be severely tried during the process of rolling if the pattern to which it has to be rolled is one composed of a multiplicity of sharp angles. Further progress in the development of the invention shows a more complete interlocking of the metal strands, and slight modifications in the section. After many experiments, it was ascertained that none of these sections gave absolute security, and that the more completely was the interlocking principle carried out the greater was the sacrifice of the flexibility. Moreover, in these later varieties, where the india-rubber strip was closely gripped and compressed by the metal, it was proved that in time it deteriorated, or underwent some chemical or physical changes of the character to which I have already alluded.

Finding, after repeated trials, that it was impossible to produce satisfactory specimens of tubing in which the tightness of the joint was secured by means of a rubber strip, the next stage in the invention was the attempt to manufacture a spirally-wound tube in which this might be accomplished by simple interlocking of the coils of metal without packing of any kind. The well-known difficulty of producing a sound joint by metal against metal would appear at first sight to interpose almost insurmountable obstacles to success in this attempt, but after further experiments, a considerable measure of success was obtained. To roll a thin strip of flat metal into the section required it would be exposed to very severe strains, in consequence of the numerous sharp angles, and it is neccessary to effect the conversion by slow degrees by the use of a graduated series of molettes through which the metal passes many times. This particular section involves six almost right-angled bends, and the manufacture can only be carried out with a very ductile metal like the best soft iron, copper, or brass. The process of evolution, which resulted in the form of metal strip now employed, was a matter involving time and much consideration; and in the latest section, packing is entirely dispensed with. In its improved form, each metal strip has a comparatively large surface in contact with the one adjoining it, and, by the difference in the width of the two grooved channels, an ample allowance is made for play. This is, in fact, a piston joint, for the smaller corrugation works within the larger one, as the piston works within the cylinder. In the first form of this joint a notch was rolled upon the summit of the lesser corrugation to receive a thread of hemp, cotton, or asbestos, to serve as a species of packing; but in the present form of the coil, the packing has been entirely done away with, and we find nothing but the two metallic surfaces in contact.

It will appear, at first sight, to practical men who have had experience in metal work, that it would be absolutely impossible, under these conditions, to produce a continuous sound joint in a tube of any length, even under very moderate pressures; but that it should be possible to obtain by this means a steam-tight joint, or one capable of conveying petroleum oil gas at a pressure of 200 lbs. per square inch, will scarcely be credited. Such is, however, an undoubted fact, and the tube is not only perfectly tight under these conditions, but it likewise retains much of its flexibility. The only explanation is that in this form of joint the greater the internal pressure, the more firmly are the metal surfaces, which approximately form two sides of a square, brought into contact. There is no possibility of torsion, or what would be equivalent to a partial unwinding of the tube, because of the friction of the metallic surfaces; and as the internal pressure increases, in precisely the same ratio does the tightness or soundness of the tube increase, until the point is reached when the strain on the metal strip produces elongation or partial deformation of the section, and in the tube $\frac{3}{4}$ of an inch in diameter, formed of a coiled-strip 6-10th of a millimetre in thickness and 14 millimetres wide, this would appear to be reached at a pressure of about 2,000 lbs. per square inch. Not only is this tube tight at these very extreme pressures, but it is also capable of being used under the diminished internal pressure of a partial vacuum, a fact which is more difficult of scientific explanation than that of its capacity for resisting great internal pressure, for in this case a new set of factors come into play. Still it will be seen,

when the structure of the tube is investigated, that the external pressure, due to the atmosphere, will also tend to tighten the coils, when the air in the interior of the tubing is exhausted.

In tubing of this formation the degree of flexibility varies, of course, considerably, in proportion to the diameter and to the thickness of metal; but, it may be roughly stated, that a 5-16th inch tube may be formed into a circle 8 inches across, and an inch tube into a circle 12 inches in diameter.

If the principle on which the construction of the latest development of the tubing is based has been made clear to you, it will be evident that there is practically no limit to the size in which pipes of this kind might be produced; it only becomes a question of the mechanical power needed to roll the metal strips into sections, and to coil them into tubes. As this is at present effected by one continuous process in a single machine, it will be understood that the production of pipes of large diameter would need a very powerful plant; there are probably, however, but few uses for flexible tubes exceeding from 10 to 12 inches in diameter.

The mechanical difficulties which had to be overcome in the manufacture of the tube, in a single operation, were by no means inconsiderable. It may be sufficient, at the present time, to indicate a few of the more prominent of them; and, in the very first rank, I must mention the production of an extremely tough, and, at the same time, highly ductile metal ribbon, or strip, of absolute uniformity and very great length. For the tube, $\frac{3}{4}$-inch in diameter, a strip of metal, 6-10ths of a millimetre in thickness and 14 millimetres in width, is needed; and, at present, the limit of length for metal strips of this section appears to be about 6,000 to 7,000 feet. As it requires about ten feet of strip to produce one foot of inch tube, the utmost length of continuous piping of this calibre is at present limited, but I am given to understand that by the process of electrical welding it becomes possible to fuse together the metal strips so perfectly that any number of sections may be united to form a tube, practically unlimited in point of length.

Having secured a strip of suitable metal, the second process is to shape it to the various complicated sections shown in the diagrams on the wall. This shaping by means of molettes is an operation of great delicacy, and the production of the sharp bends, seen in the piston-joint section, needs very accurately adjusted pressure and very skilfully graduated molettes. The final process is that of coiling the corrugated strip in a spiral form round a core, thus forming the tube. In this operation the tension of the strip, the accurate adjustment of the metal surfaces, and the mode of release from the core, are the matters of chief moment. As already stated all these operations are now accomplished in a single machine which, from the plain strip, produces the tube complete and ready for use, in one continuous process.

It may be interesting, in connection with the subject of flexible tubing, to glance at some of its more prominent industrial applications. And here we may at once distinguish between two sets of conditions which come into play in this connection, namely, in the first instance, the flexibility alone, and, in the second, the capacity of the tube to withstand internal or external pressure. In the case of an ordinary india-rubber tube we find the first of these conditions most completely satisfied. A tube of this kind is capable of being very readily bent into any required form, and possesses most perfect pliability, but under the second set of conditions it takes a very low rank. If an india-rubber tube has to withstand pressure, even to a very moderate extent, it has to be greatly increased in thickness, and it becomes extremely rigid and cumbrous. Or it must be bound round with wire or strips of metal to keep its elasticity within bounds, which deprives it of its flexibility. Again, if it has to resist a partial vacuum, the rubber tube comes off badly, as it speedily collapses and suffers a great loss of calibre.

It is in both of these latter tests that the flexible metallic tubing takes such a high rank, and while it is capable, as has been seen, of resisting such extreme pressures as 2,700 lbs. per square inch, it can also be used under a vacuum approximate to that under which water is lifted, say 30 feet. When exposed to bursting pressure, the flexible tubing has been proved, as already stated, to remain watertight until a point very near the limit of strength of the metal ribbon of which it is composed. One great superiority of the flexible metal tubing over similar tubes of other material, is its power of supporting a heavy load placed upon it, either designedly or by accident. From experiments specially made for this paper it has been ascertained that the various sizes of tubing will support the undermentioned loads gradually placed on one square inch of bearing surface:—

Internal diameter of tube.	Weight in cwts. needed to compress tube to an oval section.	Weight in cwts. needed to crush tube.
5-16th inch	13	27
3-8th ,,	10	27
½ ,,	13	31
5-8th ,,	13	35
¾ ,,	18	42
1 ,,	18	49

A tube lying on the floor can thus be trodden upon with impunity, indeed a heavy cart might be driven over it on the road, and this feature alone is of the utmost importance when the question of the use of gas is considered. When gas is conveyed through a rubber tube, and the tube is stepped upon or otherwise compressed, the gas goes out, and an immediate escape of gas takes place. This is an undoubted element of danger in connection with the use of rubber tubing for the conveyance of gas, and the officers of insurance companies and others interested would do well to satisfy themselves of the important advantages in point of safety, possessed by the new tubing. The metallic tubing will also withstand, without injury, an increase of temperature which would entirely destroy tubes of india-rubber.

It is claimed for the flexible tubing, moreover, that it will not kink, and in its application to the diving-bell, this is a property that should secure its immediate introduction, for many fatal accidents have been ascribed to this defect in the tubing now employed. The comparatively trifling weight of the flexible tubing, as compared with its great strength, should lead to its adoption for many purposes in remote and distant countries where rigid metal tubing is now used, and it will undoubtedly form part of the equipment of the explorer in opening up new territories. For it must be remembered that it can be coiled away into a very small space, and that by the use of screw couplings the joints can very rapidly be made with unskilled labour. It does not require to be protected by placing it in trenches, and it is not attacked by white ants. This last fact is a point which has been strongly commended by those who have had experience of rubber tubing in hot climates.

Another matter, which is an important one, more especially in connection with the larger sizes of tubing, is the fact that expensive bends which need special patterns, take a long time to make, and require very careful and accurate fitting, are entirely dispensed with by the employment of this material, as it can readily be adjusted to the most complicated curves, and when once placed in position it retains its form unaltered.

For many purposes on board ship, where, owing to the constant motion and straining that takes place, all ordinary rigid tubing is found to be exposed to leakage and fracture, the flexible tubing can be utilised with perfect safety, as it will expand very considerably without any loss of tightness. It is probably owing to this fact that the new tubing is not liable to be damaged by frosts, and long-suffering householders who have annually to face heavy plumbers' bills, and the discomfort of a deluge of water, will hail an unbreakable pipe with acclamation.

In the course of the foregoing observations certain of the possible applications of the flexible metallic tubing have been noticed. I may now briefly enumerate some of the many purposes for which it has lately been employed. It is used to convey air under pressure for driving rock drills and boring machinery. It has been found perfectly steam-tight, and it was employed at the recent Royal Naval Exhibition to carry steam at pressures ranging up to 150 lbs. per square inch. It is, however, quite capable of resisting, under actual working conditions, even more severe tests than this, for a considerable quantity of the flexible tubing has been supplied to one of the leading railway companies to carry petroleum gas from the reservoirs to the carriages under a pressure of, in some cases, 200 lbs. per square inch. The tubing has also been applied with complete success to the pumping of petroleum oil, a liquid which has a peculiarly subtle power of penetrating joints of every description, and which furnishes a specially severe test for a flexible tube of this nature. In the manufacture of varnishes, in jam-making, in various brewery operations, for the suction pipes for publicans' beer-engines, for organ-blowing purposes, for carpet-beating machinery, and for speaking tubes, the new tubing has been used most successfully.

An extensive field of usefulness can be predicted for this invention when employed for covering insulated wires for telegraphic and telephoning purposes. I have here some specimens of small cables sheathed with the tubing. It would be quite impossible to drive a nail through a wire thus protected, and it would be

practically impossible to crush it or to injure it by friction in the ordinary way, which points to its use for the shore ends of cables. The cheapness of this mode of manufacturing the armoured wire would be greatly in its favour. The tubing has been proved to be most valuable in lighthouses for supplying the oil to the wicks, which, as is well known, are moved by automatic machinery, and need a permanent flexible connection with the oil vessels.

In all cases, where a certain amount of flexibility is needed, together with the property of retaining the form when bent, the new material will be found to possess just that degree of stiffness that is needed. It is quite possible to produce tubes having a greater or less degree of flexibility, according to the requirements of the user, as this property depends, to a great extent, upon the form of the corrugations and the thickness of the metal strips employed.

The tubing has been used for cooling purposes, to cover large shafts revolving at a high speed, and it might also be employed with advantage in the formation of worms for distilling and condensing apparatus. It has been applied to the hot calenders used for printing machines, and it has also been employed for gas irons for collar-dressing, &c.

In circumstances where a large temporary gas installation has to be rapidly carried out, or where workmen's benches have to be supplied with movable gas burners, as also in chemical laboratories for the Bunsen burners, the flexible tubing would be found most convenient. As already stated, it has been found to answer well as a suction pipe for hydraulic and pumping purposes.

Some few details respecting the weight of the tubing may be of interest. Thus, the tubing 5-16th inch in diameter, at present the smallest size made, weighs $2\frac{1}{2}$ oz. per lineal foot—

$\frac{3}{8}$-inch	tubing	weighs	3 oz.	per foot.
$\frac{1}{2}$	,,	,,	4	,,
$\frac{5}{8}$	,,	,,	$6\frac{1}{2}$	,,
$\frac{3}{4}$	,,	,,	$8\frac{1}{2}$	,,
1	,,	,,	11	,,
$1\frac{1}{4}$	,,	,,	15	,,
$1\frac{1}{2}$	,,	,,	17	,,

The two smaller sizes have been tested up to 2,700 lbs. per square inch of hydraulic pressure, the $\frac{1}{2}$-inch diameter tubing has withstood 2,000 lbs. per square inch; the larger sizes carry a gradually decreasing pressure down to 1,500 lbs. per square inch for the 1-inch tubing, but the bursting pressure depends somewhat on the gauges of the metal strips used in the manufacture of the tubing.

A matter of great importance in the practical employment of tubing is the possibility of forming a good and secure joint or coupling, and this has been very successfully effected by means of a simple screw connection. A conical cup is provided, into which the tubing is fastened by hemp, with white lead or with solder, in the usual way, and a double thread union, with screw nut, serves either to connect the tube, or to attach it to another length of tubing; in this latter case, a second cone-end is provided for the other tube. For gas tubes, a simple "push-on" connection may be employed with advantage. Where a strong joint for low pressures between two lengths of tubing of the same size is required, the simple collar joint, made in halves, and capable of being bolted together round the junction with a packing of india-rubber is all that is needed. It must be borne in mind that under no circumstances must tubing of this description be screwed, as this tends to destroy the helical structure and to expose it to leakage.

The price of this new tubing compares very favourably with that of similar tubes of rubber, and when its superior strength and durability are taken into consideration, any slight additional expense at the outset will soon be compensated for.

I have now brought under your notice some of the more important varieties of flexible tubing. It has been my endeavour to set forth the principles on which, in tubes of metal, this property is based, and to explain how success may best be ensured in the production of such tubes. In conclusion, a new invention has been described, which, I believe, will be found to satisfy the conditions that have been laid down. I hope to have succeeded in convincing you that in the flexible metallic tubing we possess a material having a very wide range of application, and a great field of usefulness in many of the leading branches of industry.

DISCUSSION.

Mr. F. Walton said he had been concerned with this tubing almost from the commencement, and, as had been shown, it had been a matter of evolution, the invention at first being rather crude, and requiring a great deal of time and money to develop it. They had now got a tube which was capable of answering a number

of purposes, though he would not say that it was absolutely perfect. They constantly had to meet different requirements, owing to the different conditions under which the tube had to work, some tubes remaining in a comparatively quiescent state, whilst others were in continuous movement. All these conditions had to be provided for by changes in the metal or in the form of corrugation; and many improvements had yet to be made.

Mr. J. IMRAY, having been employed in specifying some of the patents for this tubing, said he had had an opportunity of watching the progress of the invention, and seeing its gradual approach to the high pitch of excellence—almost of perfection—at which which it had now arrived. The very idea of making a tnbe of this kind appeared, at first sight, to involve an impossibility. To bend a strip of steel or other metal into six right-angled bends, and then coil it round a small mandrel, and yet keep it entire, one would have said was impossible, but yet it had been done. It was not done at first, however; it required a good many trials. The most remarkable thing about the tube was its air-tightness, which was produced by the mere contact of two surfaces of the same metal, which yet moved to and fro over one another. It had been suggested that the inside pressure kept one surface against the other, and so kept it tight, but that could hardly be the explanation, because there was quite as much pressure against the outer surface tending to push it away from the inner. Nor could it be the pressure outside, because it remained tight whether the pressure were great or small. After some consideration, he ventured to offer a suggestion, though he might be in error about it, and that was this. When the piece of steel, which might be con-
ered a girder, having two pockets on one side and
n the other, was bent round a mandrel, it was
er very great stress, the outer part being put
and the inner part in compresaion; but
t be somewhere in the thickness a neutral line
here was neither. That neutral line was about
the contact took place, and the outer surface
g under great tension and the inner under great
npression, there must be a tremendous pressure of
e surface on the other, and that made the joint
tight, whether the pressure inside the tube were great or small. He had seen the different sections of metal for the tube, and the way it was produced by successive molettes or rollers, and to watch the action of the machine itself was exceedingly interesting. At one end you saw a plain strip of steel going in; it passed through successive rollers and round a drum, on which friction was produced sufficient to drag it forward, and it came out with some six right-angled corrugations formed on it; then it went on to the mandrel, and gradually wound itself up into a tube of indefinite length. He had seen a great many machines, but never one which gave him so much gratification to look at, producing a most beautiful flexible air-tight tube, which was almost perfection.

Professor ELGAR, LL.D., said this invention would be very important in many ways for marine engines. The tightness of the tube under pressure, he thought, might be due to a similar action to that which took place with an ordinary cup and leather washer in a hydraulic engine. Any internal pressure must tend to open out the parts of the pipe at the joints, and the greater the pressure the more tightly would the surfaces be pressed together. It would be the same with external pressure, there would still be the cup and washer action. There could be no better test of the tightness of a joint than petroleum, for it was constantly found that tanks which would stand any amount of water pressure, when filled with petroleum were not tight. If the life of a tube made on this principle proved to be a long one under steam pressure, it would be a most valuable invention, but he did uot know how far the deposit, which always took place after continuous working with steam or water, would affect the flexibility.

Mr. LORRAIN said Mr. Imray's suggestion was one which required some consideration—being put forward at the moment he did not quite follow it; and it seemed to him that if the effect was due to the compression at the bottom of the ribbon and the tension at the top, the greater the distance between the datum or median line and the extremes, the greater would be the resistance to leakage. That might be discovered by trying strips in which the depth of the pockets varied. If Mr. Imray's theory were correct, it seemed to him that the deeper the pockets, the greater should be the resistance.

Mr. IMRAY intimated his dissent.

Mr. LORRAIN said he might have misunderstood Mr. Imray. It occurred to him that passing steam through the pipe under considerable pressure would produce a couple which would tend to pull the outer strip round in the direction of the hands of a clock, which would increase the pressure between the two surfaces.

Mr. WALTON said he had no doubt some deposit would take place in steam pipes after a time, but, as yet, they had found no inconvenience from this in their own practice.

Mr. C. U. GRAY doubted whether this tube would be useful for electrical purposes either for the shore ends or cables, or otherwise. The shore end of a submarine cable was subjected to very rough usage on a rocky shore, and if this tube got fouled by any rock or projection, it might open up the metal, and allow that great enemy of submarine cables, the *teredo*, to enter and feast on the internal core. To cover an ordinary cable with a tube of that kind seemed somewhat risky for two reasons; though the tube might be perfectly tight, it would be impossible with so many jonts in a long length to

prevent moisture, and in some cases gas, permeating into the cable and interfering with the insulation or destroying the insulating material. Another thing was that by bringing two metals together which had been subjected to a strain for some time, so that they were in a distinctly different molecular condition, you might set up an electrical action which would corrode and wear the joints. He feared that if used for steam the continued expansion from change of temperature would in course of time interfere with the shape of the coils, and that would lead to leakage.

Mr. PEREGRINE BIRCH thought the reason for the resistance to internal pressure might be what Mr. Imray suggested, but he did not see how it would account for tightness against external pressure, which he understood was equally marked. He should like further information on that point.

Mr. H. EDMUNDS said that some eighteen months ago, as a cable manufacturer, he saw in the discovery a means of improving the present method of armouring or protecting cables. The ordinary stranded wire armour had the disadvantage that the strands being parallel there was an opportunity for anything to pierce in between the strands—to get in between the joints of the armour. Any hard solid metal, such as iron or copper, was not flexible, and lead was too soft; but this flexible tube seemed to afford a solution of the problem. He did not know that it would be particularly applicable for the shore ends of submarine cables unless further protected by wire strands; but if you were wiring a building, it would be very serviceable. If you put a wire in a plaster wall, some one might drive a tack into it; and a nail would go through the strands of a wire armour, or even a leadpipe, but not through this steel tube. On the other hand, there was the question of durability to be considered; in a dry situation it might be considerable, but he did not know how long it wonld resist damp, oxidation, and rust.

Mr. WALTON said he had made the following experiment with regard to exterior pressure:—While there was a pressure inside one of these tubes of 40 lbs. to the square inch, he told a workman to hammer the tube out into an oval; that was done for about four inches; and there was not the slightest leakage. It was then hammered back again into its original shape, and it still remained tight.

Mr. BATCHELOR asked if the tube would still retain its flexibility under a pressure of 2,000 lbs. That would be very important in some cases, as in the use of a hydraulic rivetter, where you wanted to follow the work.

The CHAIRMAN said the late Sir William Siemens had made an armour for electric cables by winding a strip of copper spirally round them, and that was used to a considerable extent, but there was no pretension that it was absolutely water-tight. This subject was evidently one of very great importance, but he did not think a flexible tube need be called upon to fulfil all the functions of every tube ever made, including rigid tubes, and therefore it did not appear to him that the merit of this invention should be judged of by inquiring whether it was suited for every possible purpose. There were many cases in which a flexible tube was an absolute necessity, and the question was whether this tube was, for certain purposes, an improvement on anything they had before possessed. Lord Armstrong said on one occasion, when the Giffard injector was a novelty, that it was a thing which no fellow could understand, and he felt inclined to say much the same of this paper, until he heard Mr. Imray. He was not quite sure, even now, that he understood it, but he got a glimmering from Mr. Imray's explanation, though even Mr. Imray did not seem to put it forward with any great confidence. But as usual with anything he put forward, if not absolutely convincing, it was certainly worth serious consideration. To his mind it was a most hardy idea to take a metal, such as soft steel, make numerous convolutions of it, amounting to as many as forty or fifty in a foot, thus having the same number of opportunities for leakage, and yet so to make it that, when finished, the tube was absolutely tight in every part. He did not know how to express his admiration for the ingenuity brought to bear on the subject, but nothing but continued use would enable one to say how it would ultimately stand the various accidents of rough usage and deposits to which it would be exposed; or how far the rough internal surface would affect the flow of liquids. All this had to be borne in mind; but, after all, if you had a tube which was flexible and tight at variou[s] pressures—including low pressures—which could [be] used in laboratories without the danger of [being] trodden on and so extinguishing the gas, w[hile] leaving the gas to escape, which was a [source] source of explosions, it appeared that it [was a] most valuable invention. He concluded by [pro]posing a cordial vote of thanks to Mr. Redgrave.

The vote of thanks having been carried unanimously,

Mr. REDGRAVE, in reply, said one or two points had been raised which evidently arose from the diagrams being misunderstood. The two colours were only used for the sake of distinctness, there being in fact only one continuous strip of metal wound on itself. In the earlier forms the tightness depended to a great extent on a strip of rubber that was gradually reduced until it became a mere thread of asbestos, embedded in what he might call the piston of the cylinder; but even that had now been done away with, and now rather a flatter section was used, in which there was no packing at all. One of the diagrams showed the

way in which the piston slid in the cylinder, when the tube was bent; but, from experiments he had made, it never seemed to go the full extent of its possible travel; so that the tightness would appear to depend on the side or flat surface, not on the end of the piston. Mr. Imray's suggestion was very interesting, and worth careful consideration; but he was not sure that it explained all the peculiarities of the tubing. The question whether it would be a satisfactory mode of protecting electric cables was perhaps rather a side issue. Its main advantage was flexibility combined with great strength and lightness, and very few tubes of this kind were required to stand an internal pressure of 2,000 or 2,500 lbs. per square inch. It could be used as a suction pipe for an ordinary pump, but it would not stand external pressure on a vacuum within to anything like the same extent as internal expansive force. At the same time, it would stand any ordinary pressure from outside without injury, the metal being so disposed as to bear the greatest pressure in that direction. With regard to degradation by atmospheric and other influences, it was quite possible such a thing might occur, but it conld be coated in various ways. Strips had been drawn through copper, showing it was possible to cover the surface with some non-corrosive metal, and he believed the Company were on the look out for some metal sufficiently tough and pliable to stand the hard usage necessary to produce the tube, and yet absolutely non-corrodible by ordinary agencies. The delta metal and manganese bronze were being experimented with, but the difficulty, as yet, was to get them sufficiently tough. The tubes, even when filled with liquids at high pressure, retained their flexibility to a great extent unimpaired.

Miscellaneous.

CHICAGO EXHIBITION, 1893.

The following letter from Mr. McCormick, the representative in this country of the Chicago Exhibition, has been received by the Secretary of the Royal Commission:—

World's Columbian Exposition,
Chicago, 1893.
London Offices, 72, Victoria-street, S.W.,
March 23rd, 1892.

Sir Henry T. Wood, Society of Arts, John-street, Adelphi, W.C.

DEAR WOOD,—There is no doubt as to the truth of what you say as to the new tariff affecting British exhibitors to an unreasonable extent.

In reply to your communication of yesterday, with enclosures from Messrs. Hulse & Co., Messrs. Hunter & English, and Messrs. Vickers, Sons & Co., as to the reply you might make to objections, I can only repeat what I have said before on many occasions, both private and public, that your manufacturers have not to look to the fostering or promotion of their trade in the United States, or to the profits to be derived from same, in considering the propriety, not to say necessity, of their making a great exhibit at Chicago in 1893. The question which will force itself upon them in the near future, and which will be accentuated at the Chicago Exposition, is, how far can they retain their present trade position in the rest of the world, that is outside the United States. Up to this time, and for some years to come, we have so much to do in the way of development of our own resources, building towns and cities, cultivating fields, bridging rivers, building railroads, developing internal navigation on lakes and rivers, and other lines of work too numerous to mention, that will require the labour of a great army of men, whose wants can be supplied, with the cheap transportation of to-day, for less money than we could provide for them at home, that for many years we must continue to exchange the product of our fields for your surplus manufactures, including articles of luxury, with the price of which our tariff does not interfere. As these great works begin to near completion, and the workmen engaged upon them must find employment and occupations which compete directly with the manufacturers who now find a large market in the United States, this market will not only grow less and less, but we will seek an outlet for our manufactures in fields hitherto held without competition by the British manufacturer. Already, in some lines, we are entering these fields and competing successfully with your manufacturers. It is not for me to urge these points upon those whom we would be glad to welcome as exhibitors at Chicago, though it is to our interests in the future that they remain away. It is rather for the Royal Commission, if its members view as I do, the importance to the British manufacturer of making a great exhibit at the Chicago Exposition, to lay before them the fact, which we fully appreciate, that we will demonstrate to the merchants from all over the world, whether or not we can supply them with such articles as they have to import to better advantage than those to whom they have gone hitherto to supply their every want.—Faithfully yours,

ROBERT MCCORMICK.

THE FRENCH PRESS.

According to the *Journal de la Société de Statistique de Paris*, the number of newspapers and periodicals of all kinds in France amounted on the 31st Dec., 1890, to 5,182, of which 2,002 were published in Paris, 3,009 in the various departments, and 171 in Algeria and the colonies. After Paris, in which city the number of papers and periodicals issued is quite exceptional, the departments in which the largest number are issued are those of the Gironde, 139;

Nord, 139; and Rhône, 132. On the other hand, the departments of the Hautes Alps and the Lozère only issue six and eight respectively. Of the 5,182 periodicals published in France, 1,640 are political newspapers, and 3,542 are miscellaneous journals and reviews. In the latter category are comprised religious papers, journals devoted to the arts and sciences, trade, sport, &c. The political journals of Paris, of which the various shades are so numerous, are difficult to classify, but in the provincial towns, out of the 1,402 newspapers 942 may be ranked as Republican and 460 Conservative. The departments which have more than 25 political newspapers are the following:—Nord, 60; Seine Inferieure, 42; Gironde, 40; Seine et Oise, 35; Eure, 33; Bouches du Rhône and Calvados 28 each; Aisne, La Manche, and Somme each 26, and the Alpes Maritimes, 25. As regards publications other than political, the classification is very different. The following is a list of the departments having more than 40:—The Department of the Rhône, 118; Gironde, 99; Bouches du Rhône, 95; Nord, 79; Haute Garonne, 46; Herault, 45; and the Alpes Maritimes, 40—in other words, these are the departments in which scientific or literary tastes appear to be the most developed. In this respect Paris appears to defy all competition, since out of 3,448 publications (non-political), there are 1,841 published in the city of Paris, while the whole of the provinces only issue 1,607. The number of political daily papers appearing in Paris is 87. Six of these cost twenty centimes the copy; fifteen cost fifteen centimes; seventeen, ten centimes; and the majority (49) are sold for five centimes a copy. Among the latter appears the *Petit Journal*, of which more than 1,100,000 copies are printed daily. One of the members of the Chamber of Deputies, M. Arène, has recently compiled a statement showing a comparison between Paris and other capitals of the number of political and non-political papers and periodicals issued. According to this statement, Paris heads the list with 2,002, of which 161 are political. London comes next with 563; New York with 231; Vienna, 67; Berlin, 66; Constantinople, 29; Madrid, 28; St. Petersburg, 22; and Rome, 21. Paris shows a considerable increase in the number of newspapers and periodicals published in 1890 as compared with 1880, for whereas in the latter year the number amounted to 2,995, in 1890 it was 5,182, an increase of 2,187, or 50 per cent. In the departments the same increase is observable, while in the colonies the number has been trebled.

SALT INDUSTRY IN THE ARGENTINE REPUBLIC.

Her Majesty's Consul at Buenos Ayres says in his last report that a new salt industry has recently come into prominence in the Argentine Republic, and one of the utmost importance to any country, so far as the welfare of its inhabitants is concerned. It has always been acknowledged that the Argentine Republic is extremely rich in natural salt, but as a rule it is too far removed from the seaboard to permit of its being properly and advantageously worked. The vast salt lakes, or "salinas," in the Rio Negro valley, and lying some 22 miles from the harbour of San Blas on the Atlantic coast, form a singular exception to the rule. These great natural salinas are four in number, and in the aggregate measure about 20,000 acres of salt-bearing ground. The level of the brine is about 15 feet below the sea level at the port of San Blas. There are enormous mountains of rock-salt exposed to the action of the air at the foot of the Andes, and upward of 250 leagues from the salinas; and it is generally supposed that it is from these deposits that the salinas draw their supply of brine. All over the salinas there are numerous springs, and the surface of the salinas is covered by supplies from the natural springs. These salinas are covered with a singularly strong brine, its density being from 30 to 35 during the winter months—that is at least 30 times stronger than the sea water at San Blas, a distance of 22 miles. The district of Rio Negro is exceedingly favourable for the production of salt, the rainfall being less than in any other district in the Republic. The strong drying winds and sun soon turn what is a vast sheet of water into a frozen lake covered with white salt. The thickness of the salt is from two to four inches, but under that again is salt and sand of about equal proportions. The season for collecting is from November to March, and the process is an exceedingly simple one. The salt is gathered into small heaps, then removed to the adjoining banks and placed into large heaps, and there it remains in this condition until removed for shipment to the different markets in the Republic. A company, under a concession from the superior Government of the province of Buenos Ayres, has commenced to work these salinas, and they are now bringing into market large supplies of all qualities of salt suitable for the different trades (saladero, hides, and meat preserving), and also for household requirements. Their supplies are only limited by the means at present at their command, but they hope to be able to supply the great bulk of the wants of the country as well as the adjoining countries of Uruguay and Brazil. This company has also erected large works in Buenos Ayres for the purpose of preparing fine salt for table and kitchen use. It is fully expected in the near future, when these salinas are in full working order, that the surplus stock will be shipped to India and Australia.

Correspondence.

SPONTANEOUS COMBUSTION OF COAL.

Having very carefully studied the paper and the discussion on "The Spontaneous Combustion of

Coal," in the Society's *Journal* of March 4th, it would appear to me that all the more important facts contained in the paper and in the discussion lead to the conclusion that the pressure of the superincumbent mass is the chief factor—is the true hypothesis of what is termed "the spontaneous ignition of coal." For nowhere in that paper, nor in that discussion, is it stated that such heating takes place in the bunkers, on the sides or tops of the masses of coal; in those positions, in fact, that are most exposed to the chemical agencies which are generally supposed to be the causes of that ignition. But, on the contrary, the mischief is invariably found to originate deep down in the stowed masses, where it is difficult to get at. "The fire, as a rule," says Mr. Lewes, "begins near the bottom of the mass of coal." And elsewhere in the paper there are statements leading to the same inference, as, for instence, where it is said, "dig down, and get at the seat of the fire." Then we find that there have been cases "in which the crew have been deluded into the supposition that all was going on well, by finding normal temperatures at the surface of the cargo, when there was a tendency to heating at the bottom of the ship's hold." Again, "In the *Carr Rock*, at starting, the thermometer indicated 75° Fahr. in her hold; a month afterwards it was 98°, and in another month 120°, whereupon they dug down into the coal." We also find the expression, "Digging down to the seat of the fire," &c.

Moreover, the stress laid upon the increase of mass in producing the phenomenon of heating also favours the hypothesis of pressure. "But unless piled in unusually large heaps, and a great deal broken, it does not, as a rule, show signs of heating." Again, "it is found that liability to ignition increases with the increase in the mass of coal." The evidence demonstrating this very remarkable result is to be found in the Report of the Royal Commission for 1875, p. 8, and clearly shows the influence of mass. "It has been before shown that the cases of spontaneous ignition in masses of coal less than 500 tons does not amount to more than quarter per cent."

We have also to take into consideration that, in ships at sea, the superincumbent mass of a heap of coal is not a static mass, but more frequently a tremendous dynamic force, that has its direction frequently changed in a rough sea, the periodical rolling of the vessel giving rise to concussions within the masses of coal from various accidents in the distribution of those masses in lading. Pressure and concussion are the physical causes of heating in other substances than coal. Heating is, indeed, the equivalent of such forces. All vegetable products packed in bulk, either green or dry, are liable to heating, and this, as in coal, deep down in the mass. Coal, indeed, is but a vegetable product in a changed state, though still containing all its original elements locked up; these elements, however, become relatively plastic under pressure. The origin of volcanic action will, in all probability, be ultimately traced to the pressure of vast superincumbent masses.

The means to avert the terrible loss of lives, of ships, and of cargoes, is obvious enough, but I will leave suggestions for the prevention of such catastrophes to some future time.

W. CAVE THOMAS.

8, Fitzroy-street, W.,
12th March, 1892.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 30.—EWING MATHESON, "Foreign Exchange." JOHN BIDDULPH MARTIN, Member of Council, will preside.

APRIL 6.—ROBERT S. MCCORMICK, Resident Commissioner for Great Britain from the World's Columbian Exposition, "The Future Trade Relations of Great Britain and the United States."

APRIL 27.—Prof. ROBERT WALLACE, "Egyptian Agriculture."

There will be no meeting on April 13.

Papers, the dates of reading of which are not yet fixed:—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"The Congo State." By Captain V. LOVETT CAMERON, R.N., C.B.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 7.—Dr. J. AUGUSTUS VOELCKER, "The Agricultural Needs of India."

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India."

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 5.—The Rev. JOHN MCLEAN, D.D., "The Red and White Races in Manitoba and the North-West." Sir CHARLES TUPPER, Bart., G.C.M.G., C.B., will preside. The paper will be illustrated by lantern slides, and a collection of Blackfoot and Sioux Indian articles.

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "Australasia: its Progress and Resources."

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—E. ROSCOE MULLINS, "The Decorative Uses of Sculpture." ALFRED GILBERT, A.R.A., will preside.

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

MAY 17.—GEORGE J. ROBINSON, "Decorative Plaster Work" (II.). J. HUNGERFORD POLLEN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

BENNETT H. BROUGH, Assoc.R.S.M., F.G.S., "Mine Surveying." Three Lectures.

LECTURE I.—MARCH 28.—*Introductory.*—Nature of mineral deposits, and the modifications of the methods of surveying required in different mines—Accidents due to inaccurate surveying—Historical sketch—The oldest mine plan—The divining rod—The use of the magnetic needle in mapping deposits of iron ore.

LECTURE II.—APRIL 4.—*Surveying.*—The compass—Ancient forms of compass—Various forms of miner's dials and theodolites—Use of aluminium for mine-surveying instruments—Supply of light for reading the verniers underground.

LECTURE III.—APRIL 11. — *Levelling.* — The level and staff for underground use—Applications of levelling in mining operations—The Carrara marble railway—Aërial wire ropeways—Hydraulic mining ditches—The St. Gothard, Mont Cenis, and Croton aqueduct tunnels—The Ernst-August adit-level—Mapping bore-holes.

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Bennet H. Brough, "Mine Surveying." (Lecture I.)

Royal Scottish Society of Arts, George-street, Edinburgh, 8 p.m. 1. Report of Committee on Mr. Laing's paper, "Distillations of Mineral Oils. 2. Report by Committee on Mr. Sutter's paper. "A Rapid Destructor for Town's Refuse." 3. Mr. John Ritchie, "On the Application of Electricity to Hoisting Machinery." 4. Mr. E. A. Browning, "On Electric Pumping and Haulage in Collieries."

Chemical Industry (London Section), Burlington-house, W., 8 p.m.

Surveyors, 12, Great George-street, S.W., 8 p.m. Professor E. Kinch, "The Valuatiou of Feeding Stuffs and Foods."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Victoria Institution, 1a, Adelphi-terrace, W.C., 8 p.m.

East India Association, Westminster Town-hall, S.W., 3 p.m. Mr. A. Cottrell-Tupp, "The Effect on the Finances and Commerce of India of the Fall in the Value of Silver."

TUESDAY, MARCH 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. E. Roscoe Mullins, "The Decorative Uses of Sculpture."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture XI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. A. R. Binnie, "Mean or Average Annual Rainfall, and the fluctuations to which it is subject."

WEDNESDAY, MARCH 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Ewing Matheson, "Foreign Exchange."

Chemical Society, Burlington-house, 4 p.m. Anniversary Meeting. Address by the President.

Patent Agents, 19, Southampton-buildings, W.C., 7.15 p.m. Mr. J. Imray, "Provisional Protection."

Civil and Mechanical Engineers, Westminster Chambers, S.W., 7 p.m. Mr. A. Wollheim, "Modern Sewage Precipitation Works: their Design, Construction, and Management."

THURSDAY, MARCH 31...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. B. A. Whitelegge, "Epidemic Waves." (Lecture II.)

United Service Institution, Whitehall-yard, 3 p.m. Lieut.-Colonel N. L. Walford, "Field Howitzers and Mortars."

FRIDAY, APRIL 1...National Indian Association (at the HOUSE OF THE SOCIETY OF ARTS), 4½ p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor Oliver Lodge, "On the Motion of the Ether near the Earth."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m.

SATURDAY, APRIL 2 ... Saturday Lecture Society, Lecture Theatre, South Kensington Museum, S.W., 3 p.m. Prof. Norman Lockyer, "Astronomy and Mythology of the Ancient Egyptians." Lecture II.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. F. Bridge, "Dramatic Music from Shakspere to Dryden." Lecture II.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxitèles, London."

Journal of the Society of Arts.

No. 2,054. Vol. XL.

FRIDAY, APRIL 1, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. Bennett H. Brough, Assoc.R.S.M., F.G.S., delivered the first lecture of the course on "Mine Surveying" on Monday evening, 29th inst. The lectures will be printed in the *Journal* during the autumn recess.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of this Committee was held on Friday, the 25th inst. Present:—Sir Frederick Leighton, Bart., P.R.A., Chairman; Henry William Banks Davis, R.A., F. Seymour Haden, Sir James D. Linton, P.R.I., H. Stacy Marks, R.A., Walter William Ouless, R.A., Lumb Stocks, R.A., Marcus Stone, R.A., the Earl of Wharncliffe, with Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

LADIES' COMMITTEE.

A meeting of the Ladies' Committee was held on Friday, the 25th ult., at 53, Berners-street. Present:—H.R.H. Princess Christian of Schleswig-Holstein, President of the Committee, in the chair; the Marchioness of Salisbury, the Countess of Aberdeen, Lady Agnes Burne, Lady Knutsford, Lady Galton, Lady Jeune, Lady Roberts, Mrs. David Carmichael, Mrs. Bedford Fenwick, Miss Forsyth, Mrs. Priestley, Mrs. Roberts-Austen, Miss Emily Shaw-Lefevre, Miss Webster, with Miss Fay Lankester, Secretary of the Committee.

ELECTRICAL COMMITTEE.

A meeting of the Electrical Committee was held on Monday, the 28th ult. Present: William H. Preece, F.R.S. (Chairman); Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Prof. W. Grylls Adams, M.A., D.Sc., F.R.S., Major-General E. R. Festing, F.R.S., Prof. George Forbes, M.A., F.R.S., Prof. David E. Hughes, F.R.S., Prof. John Perry, D.Sc., F.R.S., Alexander Siemens, C. E. Spagnoletti, Major-General C. E. Webber, C.B., Peter William Willans, James Wimshurst, with Sir Henry Trueman Wood, Secretary to the Royal Commission.

MAURITIUS COMMISSION.

The Governor of Mauritius has informed the Chairman of the Royal Commission of the appointment of the following local Committee, to make the necessary arrangements for the representation of Mauritius at the Chicago Exhibition:—The Hon. Sir V. Naz, K.C.M.G. (Chairman); the Hon. W. Newton, Q.C., the Hon. C. F. H. Adam, the Hon. W. T. A. Edwards, M.D., the Hon. J. Fraser, C.M.G., the President of the Chamber of Agriculture, the President of the Chamber of Commerce, L. Antelme, jun., G. Bouic, A. Daruty de Grandpré, F. Nash, C. Poupinel de Valencé, M.P., and A. Wemyss. The Governor has appointed Mr. W. Arthur Edwards, member of the Royal Agricultural College, Cirencester, to be agent for Mauritius at the Exhibition.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Intending exhibitors are reminded that applications for space must be made immediately, as the allotment of space is now proceeding. Most of the available space is now occupied, and no time should therefore be lost by manufacturers desiring to be represented.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

INDIAN SECTION.

Thursday, March 24, 1892; Sir JOHN STRACHEY, K.C.S.I., C.I.E., in the chair.

The paper read was—

THE OPIUM QUESTION.

By G. H. M. BATTEN.
Formerly of the Bengal Civil Service.

The violent and persistent attack, by an English association, on one of the most valuable of the products of India, with the avowed object of sweeping it from the face of the earth, renders it the duty of everyone who has the welfare of India at heart to examine the grounds on which that attack is made. Having for a long period served the Government of her Majesty the Queen in India, and having had special opportunities of making myself familiar with the facts relating to Indian opium, I accepted the invitation of this Society to read a paper on the subject, with the desire to help, so far as in me lies, to clear away the widespread ignorance of it which prevails in this country.

Apart from moral considerations, the question, so far as India is concerned, is generally discussed as if it were one affecting only the public resources of the Indian Administration, but it is much more far-reaching. The amount of revenue realised is but a part and not the greater part of the actual pecuniary value of the poppy crop and its products, while the well-being and happiness of hundreds of thousands of the people of India would be greatly affected by its extinction. I propose in this paper first to show the real value of that crop, and what it is that India is asked to sacrifice in order to satisfy the theories of a party of English philanthropists, whose excellent intentions in the cause of morality are only equalled by their determination to ignore all but the one side of the question, on which they have fixed their attention, and which serves their purpose.

It must be admitted that one of the surest signs of the progressive prosperity of a country is the increase of its external trade. The conditions which favour the development of foreign commerce are peace and liberty; the establishment of good and equable laws and their just administration; the utmost freedom, consistent with the rights of others, to individuals in utilising the sources of production at their disposal; the extension of facilities of communication within the country and with other countries; lightness of taxation—in a word, all the conditions of good government. Tried by this test, the British Government of India can show a splendid record. So long as the exclusive trading privileges of the East India Company existed they acted as a check on the free development of foreign trade, but on their final abolition in 1833, when the trade of India was thrown open to the mercantile world, it rapidly increased. In 1833-34 the value of the total exports of merchandise from British India was under Rx. 8,000,000 sterling. In fifteen years after that, they had about doubled. The increase then became more rapid, and, when assisted by the extension of railways in India, advanced by leaps and bounds. In the year 1890-91 the value of merchandise exported from India was over Rx. 100,000,000, or more than sixteen times the exports of 1833-34.

Long before British rule was established in India, opium was exported thence to China, and the trade in it, in common with all other trade, naturally developed under that rule. In the five years ending with 1833-34, the average quantity of opium exported was about 17,500 chests. The highest point to which it has ever attained was in 1879-80, when 105,508 chests were exported, but the present average is about 90,000 chests. Thus, while the general exports have increased fifteen fold, opium exports have increased only about five and a half times in volume in fifty-seven years. The cause of this will be found in the restrictive measures of the Government of India, to which I shall presently refer.

India is essentially an agricultural country, and nearly the whole of its exports consists of products of the soil. One of the most important and valuable of these products is the opium-yielding poppy. It is impossible to state with accuracy when this plant was first introduced into India. There is little record of its early history, but it is known that the Muhammadans had succeeded, in the 15th century, in introducing the cultivation of the poppy into Cambay and Malwa, and that when the Emperor Akbar, in the latter half of that century, established the Moghal Empire over Central India, he found Malwa opium a characteristic product of that country.

Dr. George Watt, who has recently compiled a complete monograph on the subject of opium, which has been printed by order of the House of Commons, points out that Abul Fazl (the historian of Akbar's times) "specially

states that poppy culture was chiefly practised in Fatehphur, Allahabad, and Ghazipur. We learn that the founder of the Moghal civil dynasty and his successors regarded opium as of necessity a State monopoly. They found it, however, at once the most convenient and successful course to farm out the right to manufacture and to sell the drug."

Dr. Bernier, the French traveller, who was in India from 1656 to 1668, speaking of the Rajputs and their martial qualities, wrote: 'From an early age they are accustomed to the use of opium, and I have been astonished to see the large quantity they swallow."

Tavernier, who was in India at the same period, incidentally mentions the Dutch trade in opium, which they obtained from Burhanpur in exchange for their pepper.

Captain A. Hamilton, in 1727, wrote: "The Chiefs of Calicut for many years had vended between 500 and 1,000 chests of Bengal opium yearly up in the inland countries, where it is very much used."

The Abbé Raynal, in 1770, described Patna as being the most celebrated place in the world for the cultivation of opium, and stated that, besides what was carried into the inland parts, there were annually 3,000 or 4,000 chests exported, each weighing 300 lbs.

There is ample evidence in the old records of the India-office, which have lately been examined by Sir George Birdwood, to prove that a large trade had been going on in opium between India and surrounding countries long before the East India Company, in 1773, undertook the supervision of the manufacture of opium in Bengal, Behar, and Orissa.

The Company, in fact, inherited from the Moghal Government this important and legitimate source of revenue on an article of luxury which India had shown itself capable of producing in high perfection, and for which there was a large demand both in and out of that country. At first they continued the system of farming out the exclusive right of opium manufacture, but this was found to entail many abuses. Amongst them was the pressure brought by the contractors, in spite of the most stringent regulations to the contrary, on the cultivators, whom they forced to carry on the cultivation, and whom they cheated in various ways. It also led to the adulteration of the drug and its illicit vend. The consequences were so injurious to the revenue, that, in 1797, the contract system was abandoned, and the Government assumed the monopoly of manufacture through its own agencies, a system which has remained in force until the present day. There was, indeed, at that time, no practicable alternative. The strongest opponent to the system of Government manufacture would hardly contend that the growth of the poppy and the manufacture of opium should have been left free and unrestricted, as that would infallibly have led to a great increase in the produce of the drug, and probably to its deterioration. On the other hand, if it ever entered into the conception of the Court of Directors to suppress, in the interests of morality, the cultivation of the poppy in the territories then in their possession, it is doubtful whether they would have had the power in those times to have done so, and it is certain that they could not have controlled the production of the vast poppy-growing tracts outside those territories in Malwa, Cambay, and elsewhere. The only result would have been that the opium consumers in India would have been supplied from sources outside British territory, and that the export trade would have been transferred to ports other than British. It would certainly have been impossible in those days to establish a Customs line to prevent the entry of opium into the Company's possessions. The Company would have sacrificed its revenue, and no one would have been benefited except the people of the territories outside the Company's possessions, at the expense of those within them.

The State monopoly continues to be administered by the Bengal Government, although its operations now extend into the North-West Provinces and Oudh. Under it, no person may cultivate the poppy except with a license from the Government, and every cultivator is bound to sell the opium produced from his crop to the Government, in whose two factories, at Patna and Ghazipur, it is manufactured into the opium of commerce. A portion of the manufactured opium is retained for consumption in India through vendors licensed by the Excise Department, and the remainder is sold monthly, by auction, in Calcutta to merchants, who export it. The Government prescribes rules for the cultivation of the poppy, the manufacture, possession, transport, import or export, and sale of opium, and any contravention of such rules is subject to stringent penalties, which may extend to imprisonment for one year or fine of 1,000 rupees, or both. Poppy illegally cultivated, and opium the subject of any offence against the law, is liable to confiscation, together with the vessels, packages, and

coverings in which it is found, and their other contents, and the animals and conveyances used in carrying it.

Like most crops, the poppy is subject to wide seasonal fluctuations, which formerly greatly affected the market prices of opium, led to speculation and gambling amongst the buyers for export, and caused corresponding uncertainty in the Government revenue. When, owing to the shortness of the supply, the price in Calcutta rose high, the direct effect was to stimulate the production of other opium competing in the foreign market with the Bengal drug, and amongst these the native production of China. Thus—and I would call particular attention to this fact, as having an important bearing on the question before us—the diminution of the supply of Indian opium to China was an incentive to the extension of poppy cultivation in China. To remedy the evils thus arising from the uncertainties of the seasons, the Government decided, twenty-five years ago, to limit the sales of opium in Calcutta to a quantity which would permit the formation of a reserve stock in plenteous years to meet deficiency in years of scarcity.

In the six years previous to 1867, the number of chests sold in a year varied from 21,423 to 64,111, and the price from Rs. 1,449 to Rs. 956 per chest. In 1867 the system of regulating the quantities annually sold, with the view of preventing such extreme oscillations in the price, was commenced.

In 1869, owing to short crops, before there had been time to form a sufficient reserve, there were less than 45,000 chests brought to auction. Sir Richard Temple, who was in charge of the Financial Department, in his Budget statement, made the following remarks:—

"The Government of Bengal is taking active measures for increasing the supply of opium for the China market to 50,000 chests annually, and for securing a reserve supply which may assure the public as to the quantity to be brought to sale, and may conduce to the checking of undue speculation in prices. There is fear that unless the supply can be improved next season, after these two deficient seasons, the cultivation of the poppy in China itself will be stimulated. For some time past positive accounts have been received of the increase of this culture in China. So it is clear that unless Bengal produces enough opium the Chinese will raise it for themselves. And if the Chinese will have opium, they may as well get it first rate from us, as second rate at home, and they may as well consume it taxed as untaxed. Again, if they do not procure it from us, they might procure it from Asia. The culture of the poppy in Persia is increasing, and some 4,000 chests are exported annually from that country."

Here we have an exposition of the policy of the Government of India. Recognising the fact that the Chinese demand a large supply of opium, and that to whatever extent India was unable to satisfy that demand, it would be met, either by increase of the produce in China itself, or by increased imports from other countries, the Government of India has thought it right, in the interests of the people of India, to shape its measures so as not to lose the natural advantages India possesses in the superior quality of its produce. Any one familiar with the records of the Government of India relating to this subject, must admit this is a fair representation of its policy and motives, and that nowhere in those records can be found any indication of a desire to stimulate the consumption of opium by the Chinese.

In pursuance of this policy, the Government yearly regulates the extent of the poppy cultivation, guided chiefly by the market prices and the stock of opium in hand. No one is forced to grow a crop of poppy against his will. The sole inducement is the price offered by the Government for the produce. For the past ten years this price has been 5 rupees a seer, which is exactly equivalent to 2½ lbs. troy. The Government makes advances, not bearing interest, before the crop is sown, and from time to time during its progress, thus saving the ryots from the exorbitant demands of the village money-lender. The crop, which is sown in the autumn and gathered in the spring, succeeds an autumn crop usually of Indian corn. The yield of opium per acre varies. For the five years ending 1889-90, the average produce per acre was a little over 16 lbs. avoirdupois, which, at 5 rupees a seer, gave the cultivator a gross return of near 40 rupees per acre. In addition to this, he receives payment for the poppy flower petals and the stalks and leaves, which are used in the factory for packing the opium cakes. The total average annual payments by the Bengal Government to the poppy cultivators exceed Rx. 2,000,000.

Besides the produce purchased by the Government, the seeds of the poppy are an important article of consumption and commerce. They are eaten parched, or employed as a condiment in the preparation of food; but perhaps their chief use is for the expression of oil, for which purpose they are not only largely used

in India, but are exported in considerable quantities, chiefly to Belgium, France, and the United Kingdom. The average produce of seed per acre, after deducting what is required for sowing, is stated to be about 260 lbs., yielding, by native processes, from 80 to 100 lbs. of oil. This oil is edible, and is used largely in Europe, either as a substitute for, or adulteration of, salad oil. It is also used for illumination, mixing with paints, soap, and varnish making. The oil-cake is eaten by the poorer classes and by cattle, being rich in nitrogen. The young seedlings, which are removed at the first weedings of the crop, are sold and eaten as a salad. I may state that these by-products of the poppy crop are perfectly free from opium.

In spite, therefore, of the labour entailed in the culture of the poppy, which requires frequent watering, and in spite of the vicissitudes of the season, which greatly affect this crop, the cultivation is popular, and the refusal of licenses is looked upon as a grievance by the ryots, as well as the landowners, to whom they pay their rent.

As I have already stated, the cultivator is bound by law to deliver the whole of the opium produced to the Government agents. It is then manufactured at the factories at Ghazipur or Patna into the opium of commerce, under the supervision of the scientific experts who are employed by the Government. The greatest care is taken to preserve the purity of the drug and the uniformity of its consistence. It is owing to this care, added to the natural advantages of soil and climate, that Indian opium has maintained its high reputation in the Chinese market, where it is admitted by the practical test of price to be far superior to the drug produced in China. Sir Robert Hart, the Inspector-General in China, in a report written in 1881, states that "the native product sells for one-half of the price obtained for the foreign drug." By "consistence" is meant the per-centage of fine opium obtained after evaporating the moisture. The standard differs in the two agencies. At the Patna factory (Behar Agency) the standard is 75, and at Ghazipur (Benares Agency) the standard is 70, for what is called "Provision opium," that is, opium to be sold for export, while for Excise opium, intended for consumption in India, the standard at each factory is 90. By the end of July the manufacture is finished, but the airing and drying are continued until October, when it is formed into balls, weighing each 3½ lbs. avoirdupois, and packed in chests. Forty balls are allotted to each chest of provision opium, which thus contains 140 lbs. From the difference of consistence a Behar chest contains 105 lbs. of fine opium, while a Benares chest only 98 lbs. of fine opium. A chest of Excise opium from the superior consistence contains one cwt. of fine opium.

The Provision opium is sent to Calcutta, where it is sold for export at auction by monthly instalments. The average quantity sold annually for the five years ending 1889-90 was 55,349 chests. During the last three of these years, and to the end of 1891, it was 57,000 a year. During the present calendar year, 1892, it has been notified that not more than 54,000 chests will be sold. In determining the number of chests to be annually manufactured and sold, the Government is guided principally by the state of the reserve stock, the aim being to keep up a reserve equal to half a year's supply. It is also guided, as I have already stated, by the prices obtained at auction. If the prices rise much, production in China and Persia is stimulated, and it is necessary to increase the production in India to maintain its market; on the other hand, if the prices fall low, and opium becomes cheap, consumption is stimulated, and the production has to be restricted. The object of the Government, as I have explained, is to maintain, so far as possible, uniformity in the price, and thus to avoid fluctuations in the market and in the revenue.

The average annual auction sale proceeds for the five years ending 1889-90, were Rx. 6,267,703, giving the average of Rs. 1,132 per chest. In the year 1890-91 they fell below Rx. 6,000,000, owing to the extension of the cultivation in China. The published statistics of the exports of opium from Calcutta, closely conform to these figures, showing an average export of 56,388 chests, valued at Rx. 6,175,542.

The Bengal Government supplies the Excise Department not only in Bengal, but also in all the other Provinces, except the Madras and Bombay Presidencies, with opium for consumption in India. The average quantity so supplied is about 4,500 chests a year, and the price credited to the Opium Department is Rs. 7¼ a seer, equivalent to Rs. 435 a chest. The average receipts from this source amount to Rx. 200,000 a year. The opium is sold to the consumers through licensed vendors, to whom it is supplied at an enhanced price, and who have to pay fees for the licenses to vend. The average receipts by the local govern-

ments from this source amount to about Rx. 800,000 a year.

The declared value of the poppy seed exported from Bengal on the average of the five years ending 1890-91, was Rx. 175,000.

Summing up these figures, we obtain the following result for the Bengal poppy crop :—

	Rx.
Auction sale proceeds on opium for export	6,000,000
Excise opium credited to Opium Department	200,000
Receipts of Provincial Government from the vend of Excise opium	800,000
Value of poppy seed exported	175,000
Total Rx.	7,175,000

In order to arrive at the ultimate annual value of the Bengal poppy crop, we must add several items which cannot be precisely estimated. These are the profits to Indian merchants and shippers on the opium exported, the profits to the Indian vendors of Excise opium, the value of the poppy seed consumed in India as seed-oil or oil-cake, and of the young plants used as food, and finally, the value of the illicit opium, which, in spite of all precautions, the cultivators are able to pass into consumption. On a moderate estimate, the value of this large trade cannot be taken at less than Rx. 3,000,000, bringing up the annual total value of the Bengal poppy crop to over Rx. 10,000,000, or, say, £7,000,000 sterling.

The territory in which this crop is produced may be described as a belt of country between 500 and 600 miles in length, with an average breadth of 180 miles, running North-West and South-East, between the 78th and 85th parallels of longitude, and the 24th and 29th parallels of latitude. The total area may be taken at about 100,000 square miles lying in the Provinces of Behar (Bengal), the North-West Provinces and Oudh. The average area cultivated with poppy for the five years ending 1889-90 was 527,200 acres, but in the last of those years was only 482,557, or 754 square miles, only three-quarters per cent. of the whole tract referred to, and this for only half the year, as another crop is almost invariably obtained from the same land during the other half. In the year 1889-90, no fewer than 1,322,355 cultivators were employed on the crop, while over 3,000 Hindoos and Muhamedans were employed by the Government in the factories and administration of the department.

The only other province in British India, where the poppy is allowed to be cultivated, is the Punjab. It is there grown under license in nearly every district. In 1889-90, the total area so cultivated was 14,458 acres, or under 23 square miles. Formerly, an acreage duty of Rs. 2 per acre was charged throughout the province, but, under new rules, it may be increased to Rs. 8, and has been increased to Rs. 4 in several districts. The cultivator may dispose of his poppy crop standing, to license-holders, who extract the opium; or he may extract the opium himself, and dispose of it, or of the produce, in the shape of poppy heads, to licensed vendors. The average annual supply of opium from this source, for the three years ending 1889-90, was something over 1,650 maunds, which would be equivalent to 1,100 Bengal Excise chests, though, probably, the opium is less carefully manufactured, and is of a lower consistency. The poppy heads are used as an infusion, forming a poppy tea, which is drank by the Sikhs, who are forbidden by their religion to use tobacco in any form. The value of the Punjab poppy crop can only be estimated. The average retail price of the opium is about Rs. 20 a seer, or Rs. 800 a maund, so that, from this source alone, it yields Rx. 132,000 on the average annual produce. Adding the value of the poppy heads, seed, and other by-products, and of illicit opium, which cannot fall short of Rx. 18,000, we get a total of Rx. 150,000, or say £100,000.

Outside of British India, the cultivation of the poppy is confined to certain native States in Central India and Rajputana, and the territory of the Gaikwar. The opium there produced is known by the generic name of Malwa opium. There are no trustworthy statistics showing the acreage under poppy, or the total quantity of opium produced. After providing for the home consumption within the native States, which must be a very large quantity, as the habit of consuming opium there has been long established and is widespread, the remainder is consumed in those parts of British India not supplied with Bengal opium, also in Hyderabad and Mysore, or is exported by sea to China, the Straits Settlements, &c.

The importation of Malwa opium into British territory is subject to very stringent regulations. Previous to the year 1831, by separate treaties with the native States, the British Government reserved to itself a monopoly of Malwa opium, which was purchased by the British Resident at Indore, and sold by auction either at Bombay or Calcutta. But in that

year it was deemed advisable, chiefly on account of the large quantity of opium smuggled to the Portuguese settlements on the coast, to relinquish the monopoly (which involved much unpalatable interference in the internal affairs of the native States), to open the trade to the operations of private enterprise, and to substitute, as a source of revenue, the grant, at a specified rate of duty, of passes to cover the transit of Malwa opium through British territory. This rate was at first fixed at Rs. 175 a chest, but as the resources of the administration for the prevention of smuggling improved, the British Government have been enabled gradually to increase the pass duty until it amounted to Rs. 700 per chest. In fixing the rate, regard is had to the prices obtained for Bengal opium. If the rate be too low, Malwa opium is unduly favoured in its competition with Bengal opium, and if it be too high, not only is smuggling encouraged, but the price of Bengal opium rises, leading either to an increased cultivation of the poppy in Bengal or in China. The present rate on opium for foreign export is Rs. 600 a chest, except on a small number of chests, weighed at Ajmere, where the rate is Rs. 625. The rate on opium imported for local consumption in the Bombay Presidency remains at Rs. 700 per chest.

All opium transported out of the native States of Central India, Rajputana, and Baroda, has to be weighed and tested at scales established at convenient places in those States under the superintendence of officers of the British Government. The transport is permitted only under passes granted on payment of the duty and by certain specified railway routes. The annual quantity passed at the scales may be taken now at 30,000 chests. A chest of Malwa opium contains the same quantity as a chest of Bengal provision opium, namely 140½ lb. avoirdupois; but its consistency is considerably higher, being from 90 to 95 per cent. of fine opium. Consequently, it has a higher average value. The average exports for the five years ending 1890-91 were 32,540 chests, valued at over Rx. 4,000,000. The remainder of the Malwa opium leaving the native States—about 2,000 chests—is consumed in India, chiefly in the Bombay Presidency; but the Madras Presidency, Hyderabad, and Mysore are also supplied from this source, and some goes to the Punjab. The value of these 2,000 chests may be taken at about Rx. 250,000, making a total value, for 30,000 chests, of Rx. 4,250,000. To this must be added, as in the case of the Bengal opium, the profits of the merchants and shippers exporting the opium, and of the vendors in India, say nearly Rx. 1,500,000.

The average annual exports of poppy seed from Bombay are valued at Rx. 212,697. They amounted, in 1890-91, to Rx. 310,930. Thus, the total annual value of the Malwa opium brought into British territory, and of the Malwa poppy seed exported from India, cannot be less than £4,000,000.

There remains to be considered the value of the Malwa opium consumed in the native States of Central India, Rajputana, and Baroda; also the value of the Malwa poppy seed not exported from India, and of the other by-products of the crop. As I have already said, there are no data available for ascertaining or estimating the acreage under poppy cultivation in the native States in question, much less for determining the quantity and value of the whole products of that crop. The population of those States is 21,750,000, or about one-tenth of the population of the rest of India. We know that the people of these States have, for centuries, been in the habit of consuming opium, we know that the restrictions placed on the cultivation of the poppy, and on the vend of opium in British India, do not exist in these States, and we know that a vast quantity of opium is smuggled out of them. If we estimate the value of the crop, exclusive of the value of the product licitly exported, at £2,000,000, it will certainly be under the real value.

The total annual value of the poppy crops in India thus appears to be as follows:—

Bengal crop	£7,000,000
Punjab crop	100,000
Malwa crop, licitly consumed in British India and exported by sea	4,000,000
Malwa crop, consumed in Central India, Rajputana, and Baroda and smuggled thence	2,000,000
Total	£13,100,000

This is divided between the producers and manufacturers, the landlords, the British and native administrations, the middlemen, merchants, shippers, vendors, &c., of India, and is paid by the ultimate consumers, principally Chinese.

Before leaving the commercial side of the question, there is one point to which I should

like shortly to refer. It is the effect on the rupee exchanges which would be produced by the cessation of the opium trade from India to China. The disbursements of the Government of India in England, usually called the Home Expenditure, are now about £17,000,000 annually. In order to provide this sum, the Secretary of State draws bills on India, which are purchased by persons in England who have to make payments, chiefly for the purchase of produce to be brought from the East for sale here. The Secretary of State's Bills are, therefore, paid by the excess of exports from India over the imports to India. It is evident that, if there were a reduction in the excess exports from India, the demand for the Secretary of State's Bills would be *pro tanto* reduced, and the exchange value of the rupee would fall. India exports to China—including the Treaty Ports—annually, merchandise to the value of near 14,000,000 of tens of rupees, the greater part of which is opium, and imports from thence merchandise and treasure of the value of very little over 5,000,000. How and where is the account adjusted? It is in England, to which China sends tea, silks, and other produce. Practically, therefore, the opium sent by India to China is paid for by remittances from England to India, which form part of the demand for the Secretary of State's Bills. The cessation of this part of the demand would, therefore, have a very injurious effect on the rate of exchange at which those bills are sold, and would increase the heavy loss to which India is put by the rise in the silver price of gold.

Thirteen millions sterling is a very moderate estimate of the sum India is asked to sacrifice annually by suppressing her opium trade. The demand for this sacrifice is made not by the people of India, not by the people of China, not by the responsible administrators of those countries, but by an irresponsible party of philanthropists seeking to obtain their ends by the despotic action of the Parliament of the United Kingdom, in which India has no representatives.

What are the reasons put forth for demanding the despotic destruction by a foreign country of a valuable Indian industry which, besides satisfying an internal demand in India itself, provides one-tenth of the whole export trade of merchandise from India?

The basis of this demand is the hypothesis that, except for medicinal purposes, the use of opium is wholly pernicious, that it demoralises and ruins, body and soul, the consumer, and that it produces no countervailing benefits which for a moment can be compared with the evils it causes.

A second reason given is that the English people have created the demand for opium by the Chinese, that they have compelled the importation of Indian opium into China by force of arms, and that they are, therefore, morally responsible for the asserted degradation of the Chinese from the use of this drug.

I shall now proceed to examine the validity of these reasons, and I shall begin with the second.

If there is one fact more certain than any other connected with this question, it is that the people of China have used opium for centuries before the people of England had any voice in the affairs of India. A valuable "Historical Note on Opium in China" has recently been drawn up Dr. Edkins, of the Chinese Customs Service, and published by order of Sir Robert Hart, the Inspector-General of the Imperial Maritime Customs of China. From this note it appears that opium was first brought to China by the Arabs early in the 8th century, and it is frequently mentioned by Chinese writers of that time. It seems at first to have been valued for its medicinal qualities; but that it was not confined to this is proved by quotations from the Chinese poets of the 10th century. One, named Su Chê, writing on the poppy, which he grew in his garden, says:—

"It is sown with wheat, and ripens with panicled millet; when growing, it may be eaten like the vegetables in spring. The seeds are like autumn millet. When ground, they yield a sap like cow's milk; when boiled, they become a drink fit for Buddha. Old men, whose powers have decayed, who have little appetite, who, when they eat meat, cannot digest it, and when they eat vegetables cannot distinguish their flavour, should take this drink. Use a willow mallet and a stone basin to beat it. Boil it in water that has been sweetened with honey. It restores tranquility to the lungs and nourishes the stomach. For three years the door has been closed, and I have gone nowhere and come back from nowhere. I see here the 'Hermit of the Shade' (a Taoist priest) and the long-robed Buddhist priest; when they sit opposite I forget to speak. Then I have but to drink a cup of this poppy-seed decoction. I laugh, I am happy, I have come to Ying-ch'uan, and am wandering on the banks of its river. I seem to be climbing the slopes of the Lu Mountain in the far West."

Recipes for the use of opium medicinally appear from time to time in the works of

Chinese writers of every subsequent century. Barbosa, a Portuguese geographical discoverer, who wrote early in the 16th century, affords evidence that the Arabs had begun to grow opium in India, and that it was exported to Siam and Pegu; and that it was brought to Malacca by Arabs and Gentiles (Hindoos) to exchange for cargoes of Chinese junks. In the Chinese tariffs of 1589 and 1615 opium is entered and rated. After citing a mass of evidence on the subject, Dr. Edkins concludes that—

"It appears plain that from the latter part of the 15th century, the manufacture of native opium has existed in China; and it is not only in recent years that there has been both native and foreign opium in this country."

It was not, however, until the first half of the 17th century that the practice of smoking opium commenced in China. This practice followed on the introduction of tobacco which was brought to China about 1620. Dr. Edkins writes:—

"In the time of the last Ming Emperor, who reigned from 1628 to 1644, tobacco smoking was prohibited, but the habit spread too rapidly to be checked by law. The origin of opium smoking is thus accounted for. Various ingredients were in various countries mixed with tobacco to try their effect; among them was opium."

In spite of repeated prohibitory edicts the habit of tobacco smoking became almost universal.

"This immense popularity of tobacco smoking was an indication of the readiness of the Chinese nation to adopt the use of narcotics. The same thing which took place in the 19th century with opium smoking occurred in the 17th century with tobacco smoking. The Confucian mind was shocked, the sense of propriety was wounded; but this did not prevent the rapid spread of both these modes of indulgence in all circles. Prohibitory edicts were issued in vain by Emperors animated by paternal affection for their people."

Opium smoking seems first to have commenced in Formosa. A native author quoted in 1746 described the process of smoking opium mixed with tobacco and hemp. It was used as an aid to sensual indulgence. In the year 1729 an edict was issued on opium smoking, prohibiting under the severest penalties the sale of opium, and the opening of opium-smoking houses. From that time forward they have been in theory a crime, but in practice have never been so treated. Opium continued to be imported and passed at the Custom-houses, and the cultivation of the poppy in China continued to extend. It was not until 1773, after the conquest of Bengal by Clive, that English merchants took up the import trade, which had steadily increased in the hands of the Portuguese, and it was not until 1781 that the East India Company became the traders in the drug. In 1767 the imports into China are said to have reached 1,000 chests, and the duty was three taels a chest. The statistics of trade from India were not then registered with the care and accuracy introduced later by the East India Company. It will be seen that the Abbé Raynal, in 1770, gives an export of from 3,000 to 4,000 chests from Patna alone. It was nominally imported as a medicinal drug, but in practice was used as a medicine and for smoking. It is thus amply proved that the English are not responsible for the introduction or use of opium in China.

In the beginning of this paper I have shown that the extension of the opium trade is only a part, and not an undue part, of the general extension of foreign trade which has developed under the English administration of India. But, it is said, the English have forced this trade on the Chinese. The war with China, which terminated in 1842, has been called the Opium War, and its immediate cause was no doubt the seizure and destruction by the Chinese of a large number of chests of Indian opium belonging to English merchants. But contemporary history shows that the real objections of the Chinese were not to the import of opium, but to the necessity of paying for it in silver. Commander J. Eliot Bingham, who served in that war, and wrote its history, shows that the imports into China of opium, metals, cotton, &c., exceeded the exports of tea, silk, &c., by 2,500,000 sterling. The Chinese held the economic fallacy that this state of things was injurious to their country, as it drained away their silver. The Imperial edicts enlarged more on the abstraction of their sycee silver than on the injury from opium to the morals of the people. One high Chinese official memorialised the Emperor "to permit the barbarian merchants to import opium as a medicine, and to require that, after having passed the Custom-house, it shall be delivered to the Hong merchants only in exchange for merchandise, and that no money be paid for it;" and further, that the exportation of money and sycee silver be prohibited. But to whatever extent the wars with China were connected with the smuggling of Indian opium, it is certain that since 1858,

when the Treaty of Tientsin was signed the Chinese Government has had a perfectly free hand in the matter of the importation of opium. By that treaty certain commercial concessions were arranged which, included the legitimatising of the import of opium, subject to a duty being levied thereon. But in the treaty itself there was no mention of, or allusion to, the opium trade. Lord Elgin wrote that he intentionally abstained from urging any treaty recognition of that trade. The preparation of the tariff devolved on Mr. Lay, the Chinese Secretary to Lord Elgin's special mission, at the desire of the Chinese no less than that of Lord Elgin. Mr. Lay, in a letter to the *Times* of the 22nd October, 1880, wrote:—

"When I came to 'opium,' I inquired what course they proposed to take in respect to it. The answer was 'We have resolved to put it into the tariff as foreign medicine.' I urged a moderate duty in view of the cost of collection, which was agreed to. This represents with strict accuracy, the amount of 'extortion' resorted to. . . . . The Chinese Government admitted opium as a legal article of import, not under constraint, but of their own free will deliberately."

In the *Times* of the 25th of same month, a letter appeared from Mr. Laurence Oliphant, who was secretary to Lord Elgin's Mission, in which he confirmed the statement made by Mr. Lay. He says he, with the Commissioner appointed by the Chinese Government, went through the tariff elaborated by Mr. Lay with the subordinate Chinese officials:—

"When we came to the article 'opium' I informed the Commissioner that I had received instructions from Lord Elgin not to insist on the insertion of the drug in the tariff, should the Chinese Government wish to omit it. This he declined to do. I then proposed that the duty should be increased beyond the figures suggested in the tariff; but to this he objected, on the ground that it would increase the inducements to smuggling. . . . . I trust that the delusion that the opium trade now existing with China was 'extorted' from that country by the British Ambassador may be finally dispelled."

In 1876, a Convention or Agreement, called the Chefoo Convention, was arrived at between the Governments of Great Britain and China, in which the British Minister, Sir Thomas Wade, promised to move his Government to make certain special arrangements as to the import of opium. These arrangements were finally carried out by an additional Article, signed at London, in 1885. By this Article an addition to the import duty of 30 taels per chest was agreed to. It amounts to a further 80 taels per chest, and frees the opium from any further duty or tax whilst in transport in the interior, being, in fact, a composition of the *likin* tax. When the package is opened at the place of consumption, it is subject to any tax which may be levied on native opium.

During the three years ending 1890, the average import of opium into China was 78,360 piculs or chests, valued at 30,577,235 Haikwan taels. The average import duty was 2,355,650 taels; the opium *likin*, 6,278,922 taels, making a total receipt averaging 8,634,572 Haikwan taels per annum. What is called the par value of a Haikwan tael, measured in gold, is 6s. 8d., that is, there are three such taels to the pound sterling. At this rate, the receipts of the Chinese Government from the import of opium are equivalent to £2,878,000 a year. The great appreciation which has taken place in the value of gold has, of course, lowered the exchange value of the silver tael, and this, no doubt, affects China in the payment of debts to gold standard countries; but for internal purposes, the value of the tael has been little affected. This large revenue, equal now to about £2,000,000, and forming more than one-third of the entire Customs revenue of China, is collected by the department presided over by Sir Robert Hart—a department admirably administered, and scrupulously accounting for its collections to the Imperial Government at Pekin. The *likin*, for which the payment of 80 taels per chest is a composition, was formerly collected as transit duties by the local Chinese authorities through whose provinces the opium passed. The Imperial Government received only such portion of the collections as they could manage to get out of the Provincial Governments, who, on the other hand, strove to retain as much as possible. The arrangements under the Chefoo Convention are, therefore, very advantageous to the Imperial Government at Pekin, which cannot afford to dispense with this large revenue derived from the import of opium.

Another result of the Chefoo Convention has been greatly improved arrangements for the prevention of smuggling of opium from Hong Kong. A mixed Commission was appointed, including a Chinese officer of high rank, which resulted in an Ordnance of the Hong Kong Legislature passed in May, 1887, by which the movement of opium into, within, and from Hong Kong is strictly regulated with the view to the prevention of smuggling into China.

It is clear then that Indian opium is now imported into China with the full approval and consent of the Chinese Government, who are at liberty to terminate the present arrangement at any time by giving twelve months' notice of their desire to terminate it. It is equally certain that Great Britain would never fire a gun to force Indian opium on the Chinese.

I have already referred to the early history of opium in China. Sir Robert Hart said, in 1881, that "Native opium was known, produced, and used long before any European began the sale of the drug along the coast." The production of opium in China has gone on steadily increasing, and has been encouraged by the restrictions and heavy taxation placed on India opium by the Government of India. All travellers and the Consular authorities testify to the vast areas under poppy cultivation. The produce of native opium has been estimated to be from three to ten times the quantity of the imported drug. Chinese opium is now much better prepared than it formerly was, and it has practically driven Indian opium out of the markets of Northern China, and, so far as we know, it supplies the bulk of the demand in the inland and western provinces. The local drug is much cheaper than imported opium. The Burma revenue officers are constantly striving to prevent importation of cheap Chinese opium into Burma.

Of the numerous recent travellers in China, I will quote only Mr. Hosie, a Consular Agent, who, in 1883, travelled from February to June through the provinces of Sse-ch'uan, Yünnan, and Kueichon. His diary has almost daily references to the extensive poppy cultivation through which he passed. In many places, it was the principal crop. With regard to the Government prohibition, he writes :—

"I have noticed in several places west of the provincial capital a proclamation dated the 9th November, 1882, by the Governor-General of Sse-ch'uan, prohibiting the cultivation of the poppy, and enjoining a more extended sowing of the cereals. It was always more or less mutilated, whether intentionally or not I cannot say. At all events, poppy was frequently growing on the side of the road opposite to that on which the proclamation was posted. It is one thing to issue instructions, another to see that they are carried out."

The prohibition is evidently in the nature of a pious opinion, meant for show and not for use.

Mr. Hosie, writing on the 5th June, 1883, says :—

"It seems superfluous daily to mention poppy as a crop. To-day, however, it was exceedingly prominent, growing everywhere on the hill-sides and bottom lands. Large rice bowls heaped with the drug were exposed at the door of almost every shop in every hamlet and village, not a bowl here and there, but several, eight being a very common number. In fact, the whole country reeks and stinks of opium."

With these facts before us, how can it be maintained that the consumption of opium in China can be affected by the imports of Indian opium, except in so far that these supply a purer and more expensive article, the suppression of which would lead to larger products of native opium of inferior quality?

I will here quote the opinion of the Rev. F. Galpin, of the English Methodist Free Church, a respected missionary at Ningpo, an important port on the east coast of China. When asked, about ten years ago, to join in a petition to the House of Commons against the opium, he refused to do so, and, in his letter of refusal, wrote :—

"I beg to express my hearty dissent from the idea presented in the petition, that the Chinese people or Government are really anxious to remove the abuse of opium. The remedy has always been, as it is now, in their own hands. Neither do I believe that if the importation of Indian opium ceased at once, the Chinese Government would set about destroying a very fruitful means of revenue. On the contrary, I feel sure that the growth of Chinese opium would be increased forthwith."

I could multiply to any extent the evidence of the extensive cultivation of poppy in China, but I think I have said enough to show that it is a fact which cannot be denied.

I will now proceed to discuss the crucial question as to the effects of consuming opium, of which there are various forms. In China the usual form is by what is called smoking opium. In India it is eaten. In Europe it is drunk in the form of laudanum, or a tincture prepared in spirits of wine. We must consider what is the effect on the average consumer, and not confine our attention to the cases of those persons only who indulge in the habit to excess, cases which I shall show are exceptional.

The Anti-Opium Society look at only one side of this question, and they arrive at their conclusions by generalising over the whole number of opium consumers the results observed or recorded in the case of frequenters of what are called "opium dens." Even in these cases they make no allowance

for the fact that many of the indulgers in the drug have been led to the habit by painful diseases, from which they have sought and found relief in opium, and that these diseases —not due but antecedent to the resort to the drug — largely account for the wretched appearance and condition of the patients. This is much as if one who derived his knowledge of the effects of alcohol solely from the gin palaces or lower drinking shops in London, should conclude that habits of intoxication, brutality, and social and physical degradation there to be seen, were typical of the mass of alcohol consumers in England; in short, that every one who was not a total abstainer was a confirmed drunkard. We know this is untrue, and that the great body of Englishmen, whether of the upper or the working classes, take their liquor in moderation and with positive benefit to themselves. So, too, with the consumers of opium in China and India. To prove this, there is the evidence of numerous Englishmen who have resided for a long time in those countries, and whose duty it has been to acquaint themselves with the facts. Some of this evidence I will put before you.

It may be safely said that all but a very small per-centage of the people of this country are absolutely ignorant of the normal effects of the habit of using opium. The popular ideas on the subject which prevail, are largely due to Thomas De Quincey who, in 1822, published the confessions of an English opium eater. Many have read this fascinating work, and many more have heard of it, and look upon De Quincey as the "shocking example" of such a habit. But I venture to say that his confessions completely disprove the allegations put forward by the opponents of the use of the drug. De Quincey (I am quoting Mr. Henry Morley) inherited a delicate and nervous constitution. His father died of consumption at the age of thirty-nine. In his youth he ran away from school, and, in the course of his subsequent adventures, passed through a period of hardship and want. He wrote, that while wandering in Wales, where he seldom slept under a roof, he was reduced to one meal a day.

"From the keen appetite, he says, produced by constant exercise and mountain air, acting on a youthful stomach, I soon began to suffer greatly on this slender regimen, for the single meal which I could venture to order was coffee or tea. Even this was at length withdrawn; and afterwards, so long as I remained in Wales, I subsisted either on blackberries, hips, haws, &c., or on the casual hospitalities which I now and then received in return for such little services as I had opportunity of rendering."

Soon after this he came to London.

"And now began the latter and fiercer stage of my long sufferings; without using a disproportionate expression, I might say, of my agony. For I now suffered, for upwards of sixteen weeks, the physical anguish of hunger in various degrees of intensity, but as little perhaps as ever any human being can have suffered who has survived. . . . Let it suffice to say that a few fragments of bread from the breakfast-table of one individual (who supposed me to be ill, but did not know of my being in utter want), and these at uncertain intervals, constituted my whole support."

To these hardships he attributes the pains, which subsequently drove him to the daily use of opium. In 1804, when he was just nineteen years of age, after suffering for about twenty days from excruciating rheumatic pains of the head and face, with hardly any respite, at the advice of a friend he took his first dose of laudanum. He thus describes the result:—

"That my pains had vanished was now a trifle in my eyes; this negative effect was swallowed up in the immensity of those positive effects which had opened before me—in the abyss of divine enjoyment thus suddenly revealed."

From this time, for about eight years, he regularly took laudanum, though not daily. He writes:—"And how do I find my health after all this opium eating?" And he thus answers the question:—

"If I dared to say the real and simple truth, though, to satisfy the theories of medical men, I ought to be ill, I never was better in my life than in the spring of 1812; and I hope sincerely that the quantity of claret, port, or 'particular Madeira,' which, in all probability, you, good reader, have taken and design to take for every term of eight years during your natural life, may as little disorder your health as mine was disordered by the opium I had taken for eight years between 1804 and 1812."

In this last year he suffered much in bodily health, from distress of mind connected with a very melancholy event, and in 1813 the internal pains he had suffered from in his boyhood again attacked him. He then began to take opium daily, and the habit so grew upon him, that in a few years he was taking it at the rate of 340 grains a day, or about half a pint of laudanum. With marriage in view, he gradually reduced it to 40 grains. In 1816 he married, and had a large family of

sons and daughters. He occasionally relapsed into excess of opium-taking, until the close of 1844. From that time he reduced his allowance to six grains a day, and in his latter years De Quincey's life passed peacefully, free wholly from distress of mind. He died in 1859, in his 75th year. Here we have, then, the instance of a man, of a naturally delicate and nervous constitution, whose early life was subject to great physical hardship, who from the age of 19 indulged in the use of opium—for a long period in excessive quantities—and who yet retained his mental qualities unimpaired, led an active literary life, was one of the most brilliant, accomplished, and intellectual writers England has produced, and who lived to the good age of 75 years.

Now what does De Quincey, with his unparalelled experience, say of the effects of opium-taking? Here are his own words with respect to its bodily effects :—

"Upon all that has hitherto been written on the subject of opium, whether by travellers in Turkey (who may plead the privilege of lying as an immemorial right) or by professors of medicine, writing *ex cathedrâ*, I have but one emphatic criticism to pronounce—Lies! lies! lies!"*

Again—

"It is not so much affirmed as taken for granted, by all who ever mention opium, formally or incidentally, that it does or can produce intoxication. Now, reader, assure yourself, *meo periculo*, that no quantity of opium ever did or could intoxicate. As to the tincture of opium (commonly called laudanum), *that* might intoxicate if a man could bear enough of it. But why? Because it contains so much proof spirit, and not because it contains so much opium. But crude opium, I affirm peremptorily, is incapable of producing any state of body at all resembling that which is produced by alcohol, and not in *degree* only incapable, but even in *kind*. It is not in the quantity of its effects merely, but in the quality that it differs altogether. . . . . The main distinction lies in this, that whereas wine disorders the mental faculties, opium, on the contrary (if taken in a proper manner), introduces amongst them most exquisite order, legislation, and harmony."

With respect to the allegation that the elevation of spirits produced by opium is necessarily followed by a proportionate depression, De Quincey simply denies it—

"Assuring my reader that for ten years, during I took opium at intervals, the day succeeding to that which on which I allowed myself this luxury was always a day of unusually good spirits."

Again—

"With respect to the torpor supposed to follow, or, rather (if we were to credit the numerous pictures of Turkish opium eaters), to accompany the practice of opium eating, I deny that also. Certainly, opium is classed under the head of narcotics, and some such effect it may produce in the end; but the primary effects of opium are always, and in the highest degree, to excite and stimulate the system. This first stage of action always lasted with me, during my noviciate, for upwards of eight hours; so that it must be the fault of the opium eater himself if he does not so time his exhibition of the dose (to speak medically) as that the whole weight of its narcotic influence may descend upon his sleep."

De Quincey, in fact, used to take his dose before going to the Italian Opera, as he found it greatly increased his mental activity and appreciation of the entertainment. He observes that it is remarkable that, during the whole period of years through which he had taken opium, he had never once caught cold (as the phrase is); not even the slightest cough. It was not until De Quincey commenced to wean himself from the habit of taking excessive doses of the drug, that he experienced what he calls the pains of opium. It kept its hold on him "by the tortures connected with the attempt to abjure it." Nevertheless, he succeeded, in a few weeks, in bringing down the quantities to a moderate amount. He writes—"the issue of my case is at least a proof that opium, after a 17 years' use and an 8 years' abuse of its powers, may still be renounced."

So much for the experiences of an English opium eater. They are quite consistent with the assertion that the moderate use of opium, by a person in good health, may be continued for years, not only without any harmful effects, but with absolute benefit.

Let us now see what is the effect on the Chinese, who resort to the more innocuous habit of smoking opium. In February, 1882, three lectures were given in St. James's-hall by the late Mr. William Brereton, and were subsequently published under the title, "The Truth About Opium." Mr. Brereton lived and practised as a solicitor for nearly fifteen years in Hong Kong, where he had daily experience of the custom and effects of opium smoking. He was in no way engaged in the opium trade, and had no pecuniary interest in it, but felt it his duty to endeavour to dispel what he called the unfounded delusions which have taken possession of the

* Since De Quincey wrote this, the views of the medical profession as to the effects of opium consumption (especially such members of the profession as have had wide experience in India and China) have greatly modified, and are now more in accordance with the conclusions of De Quincey.

public mind on the subject. His book is a storehouse of facts and arguments. It is written in a bright and intelligent style, and I strongly recommended its perusal to any one interested in the question. The facts have never been denied, or the arguments answered by any one having a personal knowledge of the subject. I shall take the liberty of quoting largely from this book.

Mr. Brereton commences by stating that, having had daily intercourse with the people from whom the best and most trustworthy information on the subject of opium and opium smoking could be obtained, his experience is that opium smoking as practised by the Chinese is perfectly innocuous, and that this is a fact so patent that it forces itself upon the attention of every intelligent resident in China who has given ordinary attention to the subject. He quotes numerous high authorities in support of this view. The first is Dr. Philip Ayres, Inspector of Hospitals of Hong Kong for many years, who both in India and in China made the subject of opium consumption a special study, and who had a large native practice amongst the Chinese.

In a report to the Government of Hong Kong for the year 1881, Dr. Ayres wrote :—

"I have come to the conclusion that opium smoking is a luxury of a very harmless description."

In an article of the "Friend of China," written by Dr. Ayres, he says :—

"My opinion is that it [opium smoking] may become a habit, but that that habit is not necessarily an increasing one. Nine out of twelve men smoke a certain number of pipes a day, just as a tobacco smoker would, or as a wine or beer drinker might drink his two or three glasses a day, without desiring more. I think the excessive opium smoker is in a greater minority than the excessive spirit drinker or tobacco smoker. In my experience, the habit does no physical harm in moderation. . . . I do not wish to defend the practice of opium smoking, but in the face of the rash opinions and exaggerated statements in respect of this vice, it is only right to record that no China resident believes in the terrible frequency of the dull, sodden-witted, debilitated opium smoker met with in print, nor have I found many Europeans who believe that they ever get the better of their opium smoking compradores in matters of business."

Another authority is Mr. John Crawfurd, F.R.S., a *savant* of high reputation, who had been Governor of the Straits Settlements, and who had resided and travelled for many years in those parts of the East and India. In 1856, he published a "Dictionary of the Indian Islands and Adjacent Countries." This is what he writes about opium :—

"Opium is at present largely consumed in the Malayan Islands, in China, in the Indo-Chinese countries, and in a few parts of Hindustan, much in the same way in which ardent spirits, malt liquor, and cider are consumed in Europe. Its deleterious character has been much insisted on, but, generally, by parties who have had no experience of its effects. Like any other narcotic, or stimulant, the habitual use of it is amenable to abuse, and as being more seductive than other stimulants, perhaps more so, but this is certainly the utmost that can be safely charged to it. Thousands consume it without any pernicious result, as thousands do wine and spirits, without any evil consequence. I know of no person of long experience and competent judgment who has not come to this common-sense conclusion."

He then proceeds to quote Dr. Oxley—

"A physician and naturalist of eminence, and who has had a larger experience than any man of Singapore, where there is the highest rate of the consumption of the drug."

Dr. Oxley wrote :—

"The inordinate use, or rather abuse, of the drug most decidedly does bring on early decrepitude, loss of appetite, and a morbid state of the secretions; but I have seen a man who has used the drug for fifty years in moderation, without any evil effects; and one man I recollect in Malacca who had so used it was upwards of eighty. Several in the habit of smoking it have assured me that, in moderation, it neither impaired the functions nor shortened life; at the same time, fully admitting the deleterious effects of too much."

Mr. Crawfurd sums up the question by this assertion :—

"Not the use, then, but the abuse of opium is prejudicial to health, but in this respect it does not materially differ from wine, distilled spirits, malt liquor, or hemp juice."

Dr. Eatwell, First Assistant Opium Examiner in the service of the Government, gave the following evidence :—

"Having passed three years in China, I may be allowed to state, as the result of my observation, and I can affirm thus far, that the effects of the abuse of the drug do not come very frequently under observation, and that when cases do occur, the habit is frequently found to have been induced by the presence of some painful chronic disease, to escape from the suffering of which the patient has fled to this resource. . . . As regards the effects of the habitual use of the drug on the mass of the people, I must affirm that no injurious results are visible. The people are generally a muscular and well-formed race, the labouring portion being capable of great and prolonged exertion under a fierce sun, in an unhealthy climate."

Dr. Eatwell concludes by observing that :—

"The proofs are still wanting to show that the moderate use of opium produces more pernicious effects upon the constitution than does the moderate use of spirituous liquors; whilst, at the same time, it is certain that the consequences of the abuse of the former are less appalling in their effect upon the victims, and less disastrous to society at large, than are the consequences of the abuse of the latter."

For many years previous to 1858, Dr. Sinibaldo de Mas had been the Envoy Extraordinary and Minister Plenipotentiary of the Court of Spain at Pekin. He had travelled much in China, India, Java, Borneo, and Malacca, and learned the Chinese language. In 1858 he published a book in French entitled "L'Angleterre, le Chine, et l'Inde," in which special reference is made to the opium question, with which he says he had made himself fully acquainted. I will quote only a few words:—

"It is a well known fact that in all these countries, notwithstanding their unwholesome climates, the opium-smoking Chinese are remarkably healthy and strong. These very opium smokers are employed as farm labourers, masons, and porters, enduring great fatigue and performing the most arduous labours; they have acquired such an excellent reputation as colonists that efforts have been made during the last few years to induce them to settle in Lima and Cuba. The per-centage of deaths among these people does not exceed the usual rate, and I must confess that having known numbers of Chinese emigrants in the various countries I have mentioned, I have never heard of a single death or any serious illness having been caused by opium smoking."

Baron Richthofen, the most experienced traveller who ever visited Sse-ch'uan, after noticing the extraordinary prevalence there of the habit of opium smoking, says:—

"In no other province except Hunan did I find the effects of the use of opium so little perceptible as in Sse-ch'uan."

Mr. Colman Baber, who knew more of that province and its people than any living Englishman, says:—

"Nowhere in China are the people so well off, or so hardy, and nowhere do they smoke so much opium."

Mr. W. Donald Spence, her Majesty's Consul at Tchang, in 1881, visited the capital of Sse-ch'uan. He reported the enormous extent of the cultivation of the poppy, and described whole districts as being one vast poppy field, and he thus speaks of the people:—

"I found the people of Sse-ch'uan stout, able-bodied men, better housed, clad, and fed, and healthier looking than the Chinese of the Lower Yang-tsze. I did not see amongst them more emaciated faces and wasted forms than disease causes in all lands. People with slow wasting diseases, such as consumption, are, if they smoke opium, apt to be classed amongst the 'ruined victims' of hasty observers; and amongst the cases of combined debility and opium smoking I saw, some were, by their own account, pseudo-victims of this type. There were some, too, whose health was completely sapped by smoking combined with other forms of sensual excess. And no doubt there were others weakened by excessive smoking simply, for excess in all things has its penalty. But the general health and well-being of the Sse-ch'uan community is remarkable; to their capacity for work and endurance of hardship, as well as to the material comforts of life they surround themselves with, all travellers bear enthusiastic testimony."

Time will not allow me to extend these quotations, although there is a mass of concurrent evidence on the subject. I will, however, add that of Sir Henry Pottinger, H.M.'s Governor-General and Minister Plenipotentiary in China, contained in a despatch written some sixty years ago, to the Foreign Office:—

"I cannot admit in any manner the idea adopted by many persons, that the introduction of opium into China is a source of unmitigated evil of every kind and a cause of misery. Personally, I have been unable to discover a single case of this kind, although I admit that, when abused, opium may become most hurtful. Besides, the same remark applies to every kind of enjoyment when carried to excess; but, from personal observations since my arrival in China; from information taken upon all points; and, lastly, from what the mandarins themselves say, I am convinced that the demoralisation and ruin which some persons attribute to the use of opium, arise more likely from imperfect knowledge of the subject and exaggeration, and that not one-hundredth part of the evil arises in China from opium smoking which one sees daily arising in England, as well as in India, from the use of ardent spirits, so largely taken in excess in those countries."

The picture drawn by the opponents of opium is that those who are in the habit of using it are a set of degraded, depraved, miserable wretches, enfeebled in mind and body, unfit for the active duties of life—thieves, vagabonds, and beggars. They do not admit —or, at any rate, never refer to the possibility of—the existence of moderate consumers, who, although they take their daily dose, are not only none the worse for it, but are actually benefited. The only exception which I have found is the Venerable Archdeacon Moule, who was for many years a missionary in China, and who has recently published his recollections of his life in that country. The Arch-

deacon is violently opposed to the opium trade, and has no words too bad for it; but he writes:—"Instances which have come under my notice make me think that opium smoking is already taking the place, not of abuse of alcohol (which it has hitherto held) in Chinese moral estimation, but of the use of alcohol; and that it is becoming possible to take the drug in moderation." He very sensibly adds that the Chinese have a fair right to say to the English people, "If you would prohibit our opium, abolish your alcohol."

But this ingenuous discovery of the possibility of the Chinese taking opium in moderation, as the mass of Englishmen take alcohol in moderation, has been known to every resident of China who has taken the trouble to inform himself of all the facts, and has not confined his attention to opium dens.

I will now examine the evidence as to the effect of opium consumption by the people of India. A Parliamentary Blue-book was published on this subject a few weeks ago. It contains the reply of the Government of India to a memorial of the Society for the Suppression of the Opium Trade, complaining of the increased consumption of the drug in India—a complaint which has been triumphantly disproved. This Blue-book contains the opinions of experienced officers engaged in the administration of the country, writing from their own personal knowledge, which it was a part of their duty to acquire, as to the effects of opium consumption on the people of India.

Now, let us see what these experienced gentlemen say. I will quote their evidence from every part of India.

The Province of Assam has a population of a little over 4,000,000, or about 2 per cent. of the whole population of British India. They consume 13 per cent. of the whole quantity of opium retailed by licensed vendors in British India. The following is the testimony of Mr. Driberg, Commissioner of Excise in Assam:—

"I am not prepared to admit that the present use of opium in Assam is a 'vice.' In most cases it is a necessity. When we first acquired Assam (I now speak of the Assam Valley) every villager grew his own opium, just as he now does his vegetables or his chillies for his curry. He had no tax to pay for his opium field, no restrictions placed on him. The former rulers recognised that a certain amount of the drug was necessary. Taking it broadly, and excluding tea gardens, the valley is inhabited by two classes; the Cacharies, Lalongs, Meches, and other aboriginal tribes, who reside on the higher submontake tracts, or along the high banks of the larger rivers, and the Hindus, the Kolitas, Koshes, Keots, and others who reside in the low-lying country, subject annually to inundation, and always damp. The former people do not use opium; they do not require it; but the lowlanders use it. They are the opium eaters of Assam. They live in a low, damp part of the country. Year after year parts of their villages are submerged and temporarily abandoned; and these people use opium to counteract the damp and malaria. They themselves say that they would die from fevers, if they did not use opium; and I have known medical men, who have had much experience of the province, hold the same view. These people are opium eaters, but not of the class described in the papers. They are good agriculturists, good subjects, and good fathers of families. They take their opium just as a good Englishman would take his peg. Of course, there are Assamese who take too much opium, just as there are Englishmen who take too much liquor; but, that opium eating is always a vice I am not prepared to admit, so far as Assamese are concerned; and, that it is increasing, I deny, and the statement I have referred to proves my view. In the Surma Valley, little opium is consumed. The people there use ganja, rather than opium; and even there, the consumption of this drug is smaller now than it was in 1874-75, and the duty is higher."

The views of Sir Charles Elliott, Lieutenant-Governor of Bengal, an officer of long and wide experience in India, will be gathered from the following paragraph of his report to he Government of India:—

"As to the proposal to limit the possession of opium to one tolah instead of five, its effect on the ordinary consumer of opium would be undesirable. A quarter of a tolah is a common, perhaps the commonest, dose taken daily by those who are addicted to the use of opium, and it is within Sir Charles Elliott's personal knowledge and experience that this quantity is taken by innumerable persons in all parts of India, from Rajputana and the Punjab to Assam, without any injury or physical deterioration; that heavy tasks are easily performed under the stimulus it supplies; and that the prevalent belief is that the stimulus is wholesome, even in a dry climate, and is especially beneficial in moist and marshy countries like Eastern Bengal. The consumer of such a dose can now procure his supply for twenty days by one visit to an opium shop; if the limit were reduced to one tolah, he would require to visit the shop every four days—an annoyance which there is no reason for imposing upon him, and the imposition of which would lead to increased smuggling and to breaches of the law."

The opium agent of Behar writes:—

"We have to consider the consumers of opium in the malarious alluvial tracts which form a great proportion of the area of these provinces. The use of

opium by these people is not so much a vice as a necessity. Their vegetable diet would not keep them alive without stimulants, and I doubt whether it would be for their benefit to stop their opium and drive them to ganja or spirits. On the comparatively dry laterite soil the people are spirit drinkers. On the alluvial mud they either use opium or the far more deleterious ganja.* I do not believe that the prevention of the cultivation of the poppy in British India would cut off the supply of a drug which bears so high a value as opium, which the people believe to be so necessary to them, and which from its small bulk is, if the smell is disguised, very easily smuggled. I also doubt whether there is any equally efficient febrifuge within the reach of the people, and whether their health would not suffer greatly if they could not procure opium. It does not appear to produce such insanity as ganja does, and, where people are as well fed as the Mahomedan ryots of Eastern Bengal, I am informed that opium smoking does not injure them. It is said to be opium smoking on insufficient food that affects the health.

"In conclusion, I may say that I believe there has been much exaggeration as to the scenes of intoxication to be witnessed in the chandu and madak shops. As I have already said, there is none in the retail opium shops. I have visited shops in which more than a score of persons have been smoking chandu or madak without seeing any person lying intoxicated, or unable to answer my questions intelligently. I have also, however, seen persons in other shops lying asleep, and presumably intoxicated, but not many. It is, I believe, usual for the smokers of chandu, the Chinese preparation of opium, to sleep, presumably intoxicated, before leaving the premises; but in the madak shops this is by no means always the case, and I have seen many get up and go away quietly from the shop after smoking the drug. They have told me that they have no desire to sleep after it."

The Commissioner of Excise in the Central Provinces writes:—

"The eating of opium (as distinguished from smoking it) in moderate quantities, though generally held in disrepute and regarded as a vice by those who do not indulge in it, is not considered to be always harmful. Indeed, the current belief is that in certain localities and for certain ages and constitutions its use may be actually beneficial and conducive to health and longevity."

The Financial Commissioner of Burma says:—

"The Chinese at Bhamo and also in Mergui assured me that they could not exist in malarious countries, such as those in which the jade and amber mines and the tin mines are situated, without opium. As far as I know the use of opium is universal amongst the Chinese and hill tribes in feverish tracts. I believe that they seldom abuse the use of the drug, and I have every reason to suppose that its use is beneficial under certain conditions."

Sir Charles Aitchison, who was Chief Commissioner of Burma, says:—

"There are large numbers of the non-Burmese community, constituting perhaps the most thriving and industrious section of the population, to whom the drug is a necessity of life, and by whom it is rarely abused."

Mr. Copleston, the Commissioner of Excise in Burma, gives similar testimony. He says:—

"The use of opium by the Chinese and natives of Madras, who consume a considerable quantity, is not known or believed to work special evil either to individuals or to society, the reason being that these people do not abandon labour and active pursuits in order to eat or smoke opium, and its bad effects are therefore thrown off. The Chinese especially are well nourished, and this fact, too, appears to be an important one. In this case opium may almost be called a legitimate luxury."

It is true that the authorities in Burma seem to have arrived at the strange conclusion that opium is a benefit to every one in that country, except the Burmese themselves, to whom it is said to be an unmitigated evil. No definite evidence of this is adduced. It seems to be based on the expressed opinion of certain Burmese gentlemen who do not use the drug.

The Government of Madras reports the result of the visit by an official to most of the "opium dens" in the town of Madras:—

"1. Most of the smoking dens were visited, and in each from 10 to 20 smokers were seen. They were of all ages—from 20 to 60 years of age—and comprised both Muhammadans and Hindus. Several professions were represented—jutka drivers, native doctors, musicians, professional beggars, butchers, sweetmeat sellers, and petty shop-keepers. Some were smokers of a few months, some of 20 and 30 years' standing.

"2. In most cases the smokers left immediately after they had finished their smoke. They purchased 8 pies to 2 annas and 6 pies worth each. Each smoker usually brought some sweetmeats or sugarcane with him, and ate or chewed it while smoking. This, it was said, was done as the opium produced a bitter taste in the mouth.

"3. To see any smoker more affected than a man who had taken his usual glass of liquor was very rare, and in such cases it was said that the man had either taken his smoke out of time or had smoked more than he was used to.

"4. No women or children were seen in the dens, and it was stated that they do not frequent them.

"5. Cases of emaciation from the effects of opium-smoking were not seen. Many of the old smokers

* Hemp.

seen were, on the contrary, very robust and well-conditioned; notably among these might be mentioned the keeper of one of the dens, a Chinaman, who is reported to have smoked for over 30 years, and who is now over 50 years of age; a vendor of country spirits, a smoker for over 20 years; and a Muhammaden Hakim of about 45, who has smoked for over 10 years.

"6. Most of those spoken to admitted that the habit once contracted was difficult to give up, but they said that it did them no more harm than the workman's glass of liquor did, if they did not exceed their usual quantity.

"7. Several complaints were made that the opium was now so dear, that what a few years ago cost 3 or 4 pies could not be purchased for 1 anna."

The report from the Government of the North-West Provinces does not enter into the question of the effect of consumption of opium on the people. The poppy is largely cultivated in these Provinces, and the facilities for the illicit use of the drug are naturally great. The absence of any mention in the Government Reports of any marked evil effects on the population is, at any rate, negative evidence that no glaring abuses exist.

The Government of the Punjab reports:—

"The ratio of consumption of opium to population is not so high as to be a cause of anxiety in regard to the health and morals of the people. In the few tracts where the habit may be said to be general among certain classes of the population, it is of old standing, and does not seem to do so much harm as might be expected. The people, on the contrary, assert that they find it a protection against fever."

The Commissioner of Excise in that province writes:—

"The Government of India requests that the general questions raised may be discussed as far as they affect the Punjab, and in replying to the Government of India it should, I think, be forcibly pointed out that, apart from financial considerations, any attempt to prohibit the sale of opium, except for medicinal purposes, would in this province be most unpopular, and consequently politically inexpedient; while, if the poppy were grown without restriction, and the sale of opium were allowed free, the consumption of opium and its preparations would inevitably increase. Sikhs, Hindus, and Muhammadans alike eat opium, and at present the residents in the Phulkian States are the largest consumers.

"The memorialists themselves admit that in malarious tracts opium is useful as a prophylactic, and I think that the opportunity afforded by the presentation of this memorial should be taken to state clearly that the poppy has been cultivated and opium eaten in the Punjab from a period antecedent to British rule: that the drug, when taken in this form in moderation, is not believed to be necessarily prejudicial; and that, although indulgence in the habit may legitimately be restricted by taxation, and thereby made a source of revenue to the State, prohibition and unrestricted consumption are alike out the question."

The Collector of Nasik, in the Bombay Presidency, writes:—

"My own opinion is—and it is formed after 23 years' service actually among the people and in nearly every part of the Bombay Presidency and of the Mysore Province—

"1. That opium smoking or eating, as practised by the vast majority of people who use the drug, is not carried to excess.

"2. That the moderate consumption of opium is no more harmful than the moderate consumption of liquor, and in many cases, like the moderate consumption of liquor, is distinctly beneficial.

"3. That the increased revenue from opium is due (*a*) to the more effectual steps taken to prevent smuggling, (*b*) to the increasing population, and (*c*) to the increasing prosperity of the people, which gives them more money to spend on luxuries.

"4. That the 'opium sot' is a much less harmful person to his family and to his neighbours, and the community generally, than the drunkard; and

"5. That Government, even if it tried, could no more prevent the consumption of opium than the consumption of drink. It would be useless to attempt to achieve either end: it would be worse than useless. It would, in my opinion, be a blunder, for I can see no weight in the reasoning that would prevent the vast bulk of the population indulging moderately in the opium luxury, simply because a very small minority harm themselves by indulging in it to excess.

"As regards those parts of India which I know well, and those alone, it is a gratuitous assumption that opium smoking causes 'widespread misery and demoralisation,' and so also is it that 'the British connection with the opium trade' is a 'serious hindrance to missionary work.' Apart from the fact that the Government of India has nothing to do with missionary work, I have never once in 23 years heard a single missionary—and I have met dozens—specially refer to or quote the opium trade as interfering with his endeavours. The proposition is true in the abstract, no doubt, but in the same manner that the abstract proposition is true that the existence of public houses in the slums of London interferes with Christian effort there."

The Collector of Khandesh, also in the Bombay Presidency, who has served many years in that district, expresses his disbelief that the consumption of opium is having any bad effects on the people of agricultural districts. He writes:—

"Reading the extracts printed in the selections

forwarded by the Government of India, it strikes me that the gentleman who penned the highly coloured accounts of opium dens must have been shown the worst haunts in large towns, and that they and those who think with them inveigh against the use of opium much as teetotallers at home attack the use of spirits and beer and wine, because of the evils of the gin palaces of our great cities. I am not prepared to admit that the use of opium in moderation is more harmful than the use of whisky. Every one who has served in Gujarat must have seen many sturdy Rajputs who took their opium regularly and were none the worse for it."

Mr. Campbell, Collector of Bombay, after quoting the accounts of opium dens given by the Anti-Opium Society, goes on to say :—

"In my judgment, the picture which these accounts give of the opium smokers is overdrawn and misleading. The statement that in Bombay houses children smoke, is supported by so much precision and detail as to make it difficult to suppose the writer was mistaken. At the same time, cases of allowing children to smoke must be extremely rare. I have never seen a child smoking, or who had smoked, or who was intended to smoke. I have never seen a child in a smoking house, except the child of one of the shopmen, who professed to be, and was, I believe, aghast at the idea of allowing his child to smoke. I have not heard, either from inspectors or smokers, of the case of a child being allowed to smoke; on the contrary, after special inquiry, the Chief Inspector assures me that such cases are unknown. As to the men smokers, and the effect of smoking on their character, appearance, and health, the descriptions under review seems to me misleading. I have no fault to find with the general description of a Bombay chandul house, given at page 9 of the reprint :—'A dirty, dilapidated, nondescript shop, with its shutters up. . . . . Raised platforms, with some hundred recumbent and semi-recumbent figures, all men, except three women and a few lads. . . . . Groups of smokers, some half lying, half sitting, others curled up, or reclining at full length.' Except that, so far as I have seen or can learn, no youths under 18 attend these smoking-houses, this description seems to me accurate. The Poonah description is also moderate :—' A low-roofed room, with 25 to 30 persons, in groups of five or six round each lamp, most of them intent on their pipes, a few in a semi - conscious state.' On the other hand, I have seen nothing to justify the following passages :—' Human swine of both sexes . . . . most immodest attitudes . . . . handsome young women sprawling on the senseless bodies of men.' Such sights, I believe, are not to found in Bombay smoking houses. In a room of 40 or 50 smokers all but three or four are awake. The bulk of them have done a hard day's work. They are tired and indolent. In opium-smoking houses assaults or acts of violence are almost unknown. Of the smokers very few are unable to answer questions clearly and readily. Even those asleep awake when lightly shaken. Even when suddenly aroused they can at once tell their name and calling. 'If you had to go out now and work, could you go?' Almost always the answer is 'Yes, we could.' Again, as to the effect of opium smoking on character. It is true a share of the smokers are beggars, and a share of them are bad characters. It is true the houses are watched by the police, for thieves meet in them and scheme crimes. Still, are all or nearly all the smokers ne'er-do-wells? Not nearly all. So far as I have seen, a Bombay opium-smoking house is much like Dr. Morison's description of a Bengal smoking house :—Almost all the smokers are of the labouring classes, tailors, day labourers, and one or two shopkeepers.' So far as I could judge by questioning the smokers in Bombay smoking houses, about two-thirds are regular working craftsmen and labourers. I asked the Assistant Collector to frame a separate estimate. His estimate was :—' At the fewest 70 per cent. regular craftsmen and labourers; at the most 20 per cent. beggars, and 10 per cent. bad characters.' I made a further personal test in three houses taken at random. The result was :—In one house of 11 smokers all were craftsmen in regular work; in a second house of 25 smokers all were craftsmen in work; in a third house of 47 smokers one was a woman, 9 were beggars, the rest were craftsmen and labourers. I have made the chief inspector take a similar test in 14 more houses. The result is, of 227 smokers 188 are workers, 38 are beggars, and one is a thief. It is probable that some among the workers are bad characters. Still care was taken to ascertain that in most cases the smokers are actually employed on the work they named. The estimate that two-thirds of the whole smokers are able to do and do regular work as labourers, weavers, embroiderers, sailors, drivers, cartmen, blacksmiths, mill hands, fitters, barbers, and also as small traders and shop-keepers, sellers of firewood, fish, tea, coffee, tobacco, and cloth seems well within the mark.

"Similarly, as regards the effect of the smoking on the health and the appearance of the smokers, the descriptions seem to me overdrawn and misleading. 'Of horrible destructions of God's image more terrible than delirium tremens, idiocy, or lunacy,' I have seen none. Of the starved and emaciated shrivelled warnings I have seen surprisingly few. The bulk of the men, I should say over two-thirds, though smokers of 8, 12, 20, and in one case of 40 years' standing, were in body and face to look at well nourished and healthy. To many of them I, in surprise, asked the question which Dr. Morison asked in Bengal :—You have smoked four or five years and are stout and strong. How is this? The explanation in Bombay is the same as the explanation in Bengal :—Smoking does not injure those who are well fed as it injured the starving. On the point of appearance and harm to health I checked my first impression by my assistant's experience. His answer

was:—'Almost none, except the old and the beggars, not more than 10 per cent. in all are emaciated.' made a personal test in three houses. In one of 11 smokers all seemed healthy and well nourished; in a second of 25 smokers, one old man was emaciated; in a third of 47, though the beggars looked dissipated, none were notably withered or broken. In the 14 houses specially tested by the chief inspector, 10 were found emaciated or slightly withered. In almost every case the emaciated and withered were over 50 years of age. So far as I can judge, the assistant collector's estimate is correct, that, except some of the old and some beggars, very few opium smokers are notably withered or emaciated."

The whole of Mr. Campbell's report deserves attentive perusal.

The last report I shall quote is that of the Commissioner in Sind. He says:—

"The society assumes that the consumption of opium, even in a moderate degree, is detrimental to man both physically and mentally. It is far from certain, however, that this assumption is correct, and we have the evidence afforded by whole tribes who have habitually, from generation to generation, taken opium. As instances may be taken the Rajputs and Bhils. Their energy, endurance, and bravery cannot be said to have been affected by their addiction to opium. Throughout the country one meets with people who take opium in moderation, and for much the same purpose and with much the same result as the English gentleman of the present day takes his wine."

Such is the evidence of persons who are in the best position to know the facts. I could add much more to the same effect. It completely establishes the contention that it is the abuse and not the use of opium which is harmful, that the moderate use is the rule, and that excess is the exception.

I now come to the proposals of the "Society for the Suppression of the Opium Trade," as to the actual practical steps to be taken to arrive at their object. I find them in a pamphlet published by the Secretary of that ociety in 1890. The first two and the fourth are thus stated:—

1. That the Bengal system of licensing the growth of the poppy and of manfacturing opium be at once stopped, except so far as may be needful for legitimate medical use.

2. That the necessary measures be at once taken, by raising the tax or otherwise, to prevent any extension of the cultivation of the poppy in Malwa, so as to compensate for the diminution of the supply from Bengal.

4. That the retail sale of opium throughout India be limited by measures having the same object as the provisions of the Pharmacy Act in Great Britain, namely, to restrict the sale to that which is required for medical use alone.

It will be observed that nothing is said of the poppy cultivation in the Punjab; perhaps the society are not aware of its existence. I assume that they would propose to stop that also. Otherwise smuggling from that province would assume enormous dimensions. Then, I would ask, what is meant by "legitimate medical use?" When we find whole tribes of people, living in malarious and fever-stricken tracts, using the opium daily as a prophylactic, is that a legitimate medical use? Or is it intended that no one shall be permitted to purchase opium except under the written authority of a duly certificated member of the medical profession? How many of the opium consumers in India are within reach of an English doctor? Could you trust the native Baids Hakims, and Pansáris, the doctors and druggists of the country, with this power? Anybody with any knowledge of India would laugh at such an idea. How then are you to meet this great practical difficulty?

It may be possible in British territory, by the exercise of despotic power, to prevent the poppy being grown, but what are "the necessary measures" so vaguely suggested for preventing its extension in the native States? Every tyro in Excise or Customs administration knows that the power to raise duties on an article in large demand is limited by the means of preventing its illicit production and sale, and that if you increase the profits of smuggling, you will proportionately have to increase your preventive measures. Unless British officers and establishments were appointed to overrun the native States, and to interfere with the agricultural operations of the people, the cessation of the growth of the poppy in British territory would infallibly lead to an enormous extension of the cultivation in native States. The export thence of opium could only be prevented by Customs barriers and patrols round Rajputana and Central India, involving a line between 2,000 and 3,000 miles in length, and heavy expenditure on the establishments. How would the native States concerned regard such measures? I have no hesitation in saying that the discontent occasioned not only in those States, but amongst our own people, including the Sikhs—from whom the flower of our native army is recruited—would constitute a very serious political danger.

I was myself in charge of a Customs' line,

2,500 miles in length, the greater part of which was maintained to keep salt produced in native States from entering British territory without the payment of a heavy duty. I am well acquainted with the evils of that barbarous system, the destruction of which I was one of the first to advocate, and spared no efforts to accomplish. It was achieved by entering into treaties with the States possessing salt sources, under which British establishments are permitted to supervise their salt works, and tax the produce before it leaves them. But this could be accomplished only by paying the States concerned compensation, in the shape of lump sums of money and annual assignments, which are met from the taxation of the salt consumed by their people. But how are you to conciliate the native States for interference in their poppy cultivation? Will the people of India, or the people of this country, submit to be taxed in order to compensate these native States, and to reconcile their rulers to an army of British preventive officers scattered over their territories? And if you reconcile the rulers by paying them, how are you to conciliate their people, who have been accustomed for centuries to the unrestricted use of opium? Without such preventive measures British India will be supplied with the Malwa drug, which, from its great value in a small bulk, is comparatively easy to smuggle. And these preventive measures must be of the strictest kind, involving the searching of the persons and goods of all travellers, and domiciliary visits, to detect the carriage, and prevent the storing of the drug.

I now come to the third proposal of the Society for the Suppression of the Opium Trade. It is as follows:—

3. That the Chinese Government be approached with proposals for diminishing the export of Malwa opium, simultaneously with the suppression of the growth of the poppy throughout China.

I do not wish to use disrespectful language, but I can hardly speak of such a proposal with gravity. The Chinese Government, who have for centuries fulminated futile edicts, threatening the heaviest pains and penalties against the growth of the poppy and the use of opium, but whose officials have never had the will or the power to enforce them, and who are known to connive at the open and unconcealed infringement of the law, are to be "approached" by the British Government, with this request:—"Now that we are doing our best to deprive you of Indian opium, which your people for centuries have demanded on account of its superior quality; now that we have, by our restrictive measures, encouraged the growth of the poppy in China, and the home production of an inferior article, to such an extent that whole provinces are covered with its cultivation; now that we are mulcting your import customs revenue of about £2,000,000 sterling a year: will you be good enough at once to stop the cultivation in China, and deprive your people of an article which we believe to be an unmitigated evil; although there is a large body of Englishmen, who, from personal experience, have testified that it is harmless to the great mass, who are moderate consumers?" How would such a request be met? If the solemn and self-possessed Chinaman has any sense of humour, by inextinguishable laughter.

But why should our philanthropy stop here? I read a statement a short time ago in a paper called the *Foochow Echo*, to the effect that some of the Chinese are planting poppy in the place of tea. If they meet with success, it is said others will follow their example and give up tea altogether. It is the competition of Indian tea in the markets of Enrope which has lowered the profits on China tea. Let us trust that India will not be asked by the Anti-Opium Society to give up producing tea, in order to prevent the Chinese turning their tea gardens into poppy fields. And what of the hypocrisy of a people who not only derive nearly half of their public revenue from the consumption of alcohol and tobacco, but support from this consumption an enormous commercial industry of brewers, distillers, hop and barley growers, merchants, importers, agents, and vendors, what of their hypocrisy in asking India and China to forego the profit derived from the opium trade?

I am aware that many of the opponents of opium would also prohit the use of alcoholic drinks in the United Kingdom, but before "approaching" China, let the people of this country set the example, and make the liquor traffic, except for purely medicinal purposes, illegal; let them forbid by law the cultivation of the hop plant, and the growth of barley for distillation or malting; let them forbid the import of wine and spirits from the Continent of Europe and elsewhere, and then they will be in a position to "approach" China with a prayer for the destruction of the poppy cultivation and the trade in opium.

It has been suggested that if the culture of poppy were prohibited other crops would take

its place and thus supply a great part of the loss. But would the farmers of Kent be satisfied if the temperance party were to say to them, "We will pass a law to prohibit your cultivating hops. You can, however, grow potatoes or gooseberries instead?"

It is true that a more moderate party in this country does not go the length of prohibiting the cultivation of the poppy and the manufacture of opium in Bengal. They are shocked at the direct management by the Government of these industries. No question has been more fully discussed in India than this, there are volumes of correspondence relating to it, but the upshot of all these discussions has invariably been the recognition of the fact that, under any other system, the cultivation could not be so well restricted, that smuggling would be more rife, that the cultivators would be brought under influences of speculators, from which they are at present guarded, and that whatever evils now exist would be largely increased. The Society for the Suppression of the Opium Trade recognise this, and in the pamphlet I have quoted, declare that the proposal is entirely inadequate, and that their demand is nothing short of absolute prohibition.

India has had the advantage of drawing from England, for more than 100 years, a number of upright, honest, and able administrators. It is remarkable that there is not a single instance of an Englishman who has been directly responsible for the well-being of India, and who has had an important voice in its administration, who has ever suggested the prohibition of the cultivation of the poppy. That has been left for a party of irresponsible persons in this country, whose want of knowledge is patent to everyone who has studied the question on the spot.

I will give one recent and striking instance. There is internal evidence that no one who joined in the memorial of the Society for the Suppression of the Opium Trade, of the 30th July, 1890, which is published in the recent Blue-book on the consumption of opium in India, had the most elementary knowledge of India, or, if there were such a person, he could not have read the memorial. In it Lucknow is described as being in the Punjab, and Lahore as being in the North-Western Provinces! This blunder is as stupendous as would be that of persons memorialising for the suppression of alcohol in Europe, who should place Paris in Scotland and Dublin in Holland.

There have just come into my hands two articles from native newspapers, published, one in Calcutta, the other in Bombay. The Calcutta paper is called *Bangavasi*. It has the largest circulation of any of the Bengal papers, being about 20,000. The following is a translation of an article which appeared in that paper on the 30th January last:—

"What harm does Government's opium business do to us? Does Government press us to eat the drug? Or is it that the sight of an opium shop creates such a craving for the article that one cannot help eating it? Now, the opium shops, as such, possess no attractions for the people, their existence merely making it easy for habitual opium eaters to buy it for their use. We believe that most of those who use opium suffer from some disease, and use it medicinally. Opium is a medicine in gout and in all diseases of the bowels and kidneys. That opium used in old age prolongs life is also a common belief. For all these reasons many people use the drug in large or small doses, and gradually become confirmed opium-eaters. It is not the sight or appearance of the opium shops, which by the way is the most revolting possible, that attracts men thereto. Nor is it the case that men eat opium for the purpose of showing their loyalty to Government, which trades in that article. Nor, again, do people go to the opium shops from the consideration that by buying opium they would help to rescue Government from its financial embarrassment. Habitual opium eaters can do without their daily bread rather than forego their regulation dose of the drug. Again opium is largely used as a medicine in all systems of the medical treatment—allopathic, homœpathic, ayurvedik. People resort to the opium shops for all these purposes, and not a man is attracted to them by their mere appearance, as is the case with liquor shops. An opium shop has nothing of the wine shop's attractive glitter of glass and beauty of label. Nor does a dose of opium produce that exhilaration of spirits which makes the wine-bibber sing and dance in joy. What attractions then does an opium shop possess for the public? We do not really see that an opium shop licensed by Government can hold out any temptations to men. Its appearance is rather calculated to repel men from it. If it had been otherwise, if the mere sight of an opium shop had been enough to attract customers, we would have freely condemned the opium business of the Government.

"A person under the influence of opium does not become querulous or boisterous. Nor does a habitual opium eater bring beggary and destitution upon himself and family, and die an untimely death. The number of untimely deaths among opium eaters is very few. If it had been otherwise, we should have been the first to condemn the opium trade, and ask Government to discontinue the sinful business.

"It is true that opium is used for committing suicide. But those that will commit suicide will

commit it even if they do not get opium for the purpose. Government does not trade in arsenic or ropes, and yet many people put an end to their lives by swallowing the former or drawing the latter round their necks. If Government discontinues its opium business, others will take it up, and there will still be cases of suicide from opium-poisoning. We are, therefore, really unable to understand what harm is done by the Government's trade in raw opium.

"These remarks apply in some measure to the different preparations of opium, and particularly to guli. The guli shops present a most repulsive appearance. As it is, however, desirable on various grounds that such shops should cease to exist, the writer would not object to Government's directing their abolition.

"What good will the changes now proposed to be made in connection with Government's opium business do to the country? And is it possible to do the amount of good that is expected? We do not see that the Government's opium business does any harm to anybody. Opium cultivation will not cease even if Government gives up the business. Nor is it desired that that cultivation should cease. Now, suppose Government gives up the business, and somebody finds himself at liberty to grow and sell and purchase opium. Suppose the opium shops, flourishing as before, with this difference only, that the signboards put up in front of the shops no longer contain the words 'By order of Government.' The accounts are made up, and they disclose a large deficit in the finances. Government, however, must meet its regular expenditure, and that means that the people must raise the money from other sources. It is thus clear that the people will gain nothing by the abolition of the Government's trade in opium."

The *Bombay Samâchâr*, a Guzerâti paper, which has the largest daily circulation in Bombay, has the following article on the 19th February last:—

"The opium agitators in England seem to be insensible to the great pecuniary loss that would be inflicted on the people of India by a prohibition against the production of opium in India and its export to China. To the ranks of the opium agitators in England an addition has now been made in the person of Miss Sundrâbâi Powâr, an Indian lady. In an address recently delivered by her at Sheffield, Miss Powâr asserted that the use of opium had created great mischief in India, and that as she could not quietly bear this sight she had gone to England to plead for the abolition of the opium monopoly. It is not known in Bombay who Miss Powâr is, and what she did while she was in India to stop the alleged evil effects of the consumption of this drug. Miss Powâr accuses the Government of India of having encouraged the opium trade in the interests revenue, but no mischief whatever, we assert, has been created in India by the consumption of opium. On the other hand, considerable evil has been caused by a free use of country and Europe spirits, particularly among the educated persons, and the Government of India is very particular about increasing its revenue from this source. Miss Powâr ought to bear in mind that there is more need for checking the consumption of spirituous drinks than the use of opium."

Mr. Samuel Laing, when Finance Minister of India in 1862, made the following remarks:—

"This much seems certain in speculating on the probable continuance of a demand for opium in China. Every civilised or semi-civilised race of mankind seems to affect some peculiar form of nervous stimulant, and as the natives of Northern Europe take to alcohol, so the Chinese take to opium. Possibly, in each case, the craving is for something to supply an innate want. The Englishman, the Dane, the German, and the Russian resort to that the specific effect of which is to raise the spirits and produce temporary exhilaration. The Chinese, whose greatest deficiency, as shown by the whole history, religion, and literature of the race, is in the imaginative faculties, resorts to that which stimulates the imagination, and makes his sluggish brain see visions and dream dreams. Be this as it may, the fact is certain that, under all circumstances and in all climates, as the Englishman is a drinker of beer, so is the Chinaman a smoker of opium. We have, at the bottom of our opium revenue, one of the great natural instincts of a large population, upon which English Chancellors of the Exchequer confidently rely for half their revenue."

I have not dealt with the comparative physiological effects produced by the use of alcohol and opium, and other drugs; but I hope some of the more scientific gentlemen here this evening will speak on this point. From all I have learnt on the subject, I believe that the excess of the use of alcohol is far more destructive to the human frame than that of opium, for one attacks the tissues and the other produces only functional derangement. If the people of India are deprived of opium, the consumers of it will infallibly have recourse to alcohol or to hemp, which grows wild in many parts of the country, and the effects of which are, when taken in excess, maddening.

Indeed much of the evil character which is given to opium is due to its being frequently adulterated with or used with hemp. The *hashish*, from which the English word "assassin" is derived, and the *bang*, which is notoriously the stimulant used by fanatics in India when intent on reckless slaughter, are nothing but hemp. It would be beyond the power even of Parliament to eradicate hemp from India.

From the mass of evidence to be found in the writings of members of the medical profession who have acquired their experience amongst the people who use opium as a stimulant, I will quote a few passages.

Dr. W. B. O'Shaugnessy, in the "Bengal Dispensatory," 1841, writes :—

"The longevity of opium-eaters is, in many parts of the East, of proverbial notoriety. . . . When the habit is but moderately followed, it appears to occasion no greater evil than the proportionate indulgence in wine or other spirituous liquors."

Dr. D. McPherson, in his book on "The War in China," 1843, has the following passage :—

"From the earliest periods in every nation, and among every people, we find some description of stimulus in common use among them; and were we to be led away by the popular opinion that the habitual use of opium injures the health and shortens life, we should expect to find the Chinese a shrivelled, and emaciated, and idiotic race. On the contrary, although the habit of opium smoking is universal amongst the rich and poor, we find them to be a powerful, muscular, and athletic people, and the lower orders more intelligent and far superior in mental acquirements to those of corresponding rank in our own country. The Chinese themselves affirm that the use of the drug acts as a preventive against disease, and, in this opinion, when smoked in moderation, I am inclined in part to agree with them. The particles, by their direct and topical influence on the nerves of the lungs, which carry the impressions they receive to the heart, brain, and spinal cord, and through them to all parts of the body, may thus, to a certain extent, guard the system against disease, and, by its tonic influence, strengthen the several organs. This opinion gains strength, when we call to mind that a peculiar active principle in opium—the narcotine—has of late been employed, with considerable success, in Bengal, as a substitute for quinine. It may also be mentioned that, at the time fevers prevailed so extensively among our troops at Hong-Kong, but comparatively few of the Chinese suffered, though exposed throughout to the same exciting causes."

Dr. Cornish, Sanitary Commissioner for Madras, drew the attention of the Government to the great consumption of opium in the Godavery district. An investigation was ordered, and the officer who reported on it, in 1874, came to the following conclusion :—

"I believe that the extensive use of opium in this district is due to the extensive prevalence of fever, and that if fever could be checked, so would the use of the drug. Conversely, I think it unadvisable to attempt arbitrarily to stop its consumption at resent."

Dr. Vincent Richards, who was in medical charge of Balasor, in Orissa, where opium-eating is very common, made very careful inquiries into the matter, and collected elaborate statistics connected with it. He wrote, in 1877 :—

"I estimated that about one in every twelve or fourteen of the adult population used the drug, and I believe the habit is somewhat increasing. The greatly increased consumption of the drug dates from the famine year 1866, when it was, if I remember rightly, nearly trebled; since when it has, I believe, pretty steadily increased. This is not the result of a growing abuse of the drug by individual consumers, but of a more extended use of it amongst the general population. There can be no doubt that opium-eating was greatly resorted to in the famine year, because it mitigated the sufferings arising from hunger and sickness, and enabled the poor people to live on less food. . . . . Opium-eating—at any rate at Balasor—does not conduce to either crime or insanity, since the inhabitants are a particularly law-abiding race, and the insanes are only ·0069 per cent. of the population. . . . . The general conclusions I arrive at are—1st, that opium is taken habitually by about 2 to 10 per cent. of the adult population of Balasor, and that the average daily allowance for a man is 7 grains, and for a woman 5 grains; 2nd, that moderation is the rule; 3rd, that moderate doses include from 2 to 16 grains *per diem*, according to circumstances; 4th, that opium-eating is much more common in unhealthy localities than in healthy ones, even though they are situated in the same district; 5th, that the drug may be, and is sometimes, taken in very large doses—30 grains and upwards—without producing any very serious ill-effect, much depending on the constitution of the individual, and his habituation to its use; 6th, that whatever the effects of the excessive use of the drug may be, when taken in moderation it is positively beneficial, where such diseases as fever, elephantiasis, rheumatism, &c., are prevalent, and when food is scarce; 7th, that the effects of even the excessive use of opium are harmless, both to the individual and to society, compared with those of the excessive use of alcohol."

The views of Sir William J. Moore, who had an extended experience in Rajputana, and was afterwards Surgeon-General with the Government of Bombay, are well known, and I hope that he will again state them on this occasion. They fully accord with those I have already quoted. There are literally volumes of evidence of a similar character.

We have, then, a great *consensus* of opinion arrived at by a number of independent persons of high character and reputation; gentlemen of ability and integrity, who have attained to responsible positions, in which they have had the best opportunities of ascertaining the truth;

whose duty it has been to state the truth; and who have had no personal interest in perverting it. They deliberately declare that the daily use of opium in moderation is not only harmless, but of positive benefit, and frequently even a necessity of life; that this moderate use is the rule, and that excess is the exception. On the other hand, we are told by a society, chiefly consisting of Englishmen who have no personal knowledge of the facts, that all this evidence goes for nothing, and that the use of opium, except for strictly medicinal purposes, is an unmitigated evil, and ruins every one who habitually has resort to it. If we accept this view, which differentiates opium from every other stimulant used by great masses of people, we must believe that all those experienced persons who have testified to the direct contrary are either grossly incapable or grossly dishonest. It is no use mincing words; a man must be one or the other who, having lived for years amongst an opium-consuming people, and having made a careful study of the effects of the habit, deliberately declares as the result of his inquiries that which is untrue. And on what is the opposition based? Chiefly on the statements of English missionaries in China. I respect the sincerity and the high and noble purposes of these gentlemen, but, as the French phrase it, they have the defects of their qualities. They are filled with a burning zeal to better the physical and spiritual condition of the poor and miserable Chinese with whom they are brought into contact. They find numerous instances of the degradation which is produced by the abuse of opium in the prosecution of the objects for which they are struggling. They are met by the astute Chinaman with the argument that opium is an evil thing, and that the English who import it into China are out of Court when advocating morality. They fall into the trap, and jump to the conclusion that it is the opium trade which prevents their making faster progress in the evangelisation of China. Only one side of the question is brought prominently to their notice, and that the worst side. Their experience is almost entirely confined to towns on the sea coast. They knew little or nothing of the millions of the healthy, industrious population in the interior of the country to whom the use of opium is as common, as moderate, and as beneficial as that of beer is to the people of England.

In conclusion, I would say to the Society for the Suppression of the Opium Trade—You may make this a party question; you may win votes relying on the uninstructed philanthropy of your fellow countrymen; you may, through Parliament, use the despotic power of the British Government to destroy one of the most valuable products of India, and subject the people to new taxation in order to supply the loss of revenue now paid chiefly by the Chinese; you may deprive hundreds of thousands of her Majesty's Indian subjects of a prophylactic which enables them to resist fatigue, to sustain privation, and to save life; you may thereby increase suffering, sickness, and mortality; you may cover India with an army of preventive officers to watch another army of smugglers, created to satisfy a natural demand of which you have suppressed the legitimate supply; you may harass the people by personal searches and domiciliary visits; you may thus create discontent amongst our native subjects, and disaffection in the best forces of our native army; you may, by unwarranted and unprecedented interference in their internal administration, and, owing to the pecuniary losses both rulers and subjects will sustain, disgust and alienate the native States of Central India and Rajputana, our bravest and most loyal allies; you may drive the consumers of opium to alcohol and hemp; you may do all this, but you will never persuade the Chinese to follow in your footsteps, and abandon the ever-increasing culture of the poppy. In short, you may inflict on India a cruel injury, the extent and the consequences of which you are incapable of calculating; but you will fail in any way to benefit China, unless you count it a benefit greatly to extend the cultivation of the poppy, and the manufacture of opium within her borders.

DISCUSSION.

Mr. SAMUEL SMITH, M.P., said the ground traversed by this paper was so enormous that it was difficult to know where to commence criticism; but, as one who had paid a great deal of attention to this question for a quarter of a century, he must say that the paper struck him as being exceedingly one-sided. It was, in fact, an official apology for the opium trade, and for all the action that this country and India had taken in regard to opium. There were many points on which he could entirely join issue with the writer, but he would only briefly allude to one or two. He was glad to see on the platform Sir Thomas Wade, a gentleman who had had a large official connection with the opium trade in China, and with whom he had had a friendly passage of arms

last year, but for whom he had a great respect. He would first direct attention to the history of our dealings with China in connection with this subject, which, after all, was the crucial point in the controversy. Mr. Batten would lead one to assume that, practically speaking, we had never intervened in the opium trade, save to carry on and continue an old and well established trade. He spoke about it having existed many hundreds of years ago, and being widely spread through China, and carried on by the Portuguese, and afterwards perpetuated by the East India Company, but he said when the East India Company took up the trade in 1773, the total export into China was only 1,000 chests, whereas now it was nearly 100,000 chests. If he was not mistaken, in the year 1767 the export of opium from India to China was only 200 chests. That was the amount of trade we inherited from the Dutch and Portuguese—simply a trade in medicine; and he did not believe that his figures could be disputed. The East India Company, however, took over the trade, and henceforth began to develop it to the utmost of their power.

Mr. BATTEN said he had not given the 1,000 chests as an absolutely correct figure; it was the only one he could find.

Mr. SMITH said his impression was that the quantity in 1767 was very small, and it was purely for the purpose of medicine. He did not believe the habit of opium-smoking had extended in China to any extent worth speaking of at that time. The Chinese Government prohibited entirely the import of opium, and treated it as a noxious and pernicious drug; but the East India Company sold it in an increasing amount year by year to smugglers, who smuggled it in contrary to the law. At the end of the last century, we had got the smuggling trade up to 4,000 chests, the trade in it growing and expanding; and the Chinese Government became more and more determined to stop it, as they observed the ravages it was making, and at last went so far as to make it a capital offence either to sell or smoke opium. They took such strong measures, that they produced the first Chinese opium war in 1839. A gentleman said "No;" but he would simply state the facts. 20,000 chests of smuggled opium were seized by the Chinese, and destroyed; whereupon the English Government made a war upon the Chinese, and compelled them to pay an indemnity for it, and a large addition to the indemnity for the costs of the war. This was one of the most disgraceful wars ever waged. Sir Thomas Wade would hardly say that was not an opium war. He was in China about that time, and afterwards became Ambassador, and he was sure he would not have justified the first opium war, though he believed he took objection to calling the second war an opium war. We forced the Chinese to pay a heavy indemnity, but could not get them to legalise opium.

Sir THOMAS WADE said we did not try.

Mr. SMITH said the Chinese Government refused to do that until after the second war, when we took the capital, and inflicted a crushing defeat upon them; and then, at last, it was legalised. He would quote from a despatch from Sir Thomas Wade himself, written to the British Government, which agreed with everything he could collect on the subject. It was written in 1868. (Mr. Smith then quoted an extract from the despatch, to the effect that every foot obtained by England in China had been obtained by force alone; that we were indebted for the safety we enjoyed at certain accessible points to force; and that all concessions made had been extorted against the conscience of the nation.) That did not look as if our arrangements with China had been amicably made. Sir Thomas Wade was succeeded by Sir Rutherford Alcock.

Sir THOMAS WADE said no; Sir Rutherford Alcock was his predecessor, and the report quoted from was one made by him as Secretary of Legation.

Mr. SMITH then said he would quote from another despatch which he believed was written by Sir Thomas Wade, and in which he gave an account of an interview with a Chinese Minister in which he complained of the hostile feelings of the Chinese towards Englishmen. The Chinese Minister's name was Wang-si-an, and in that interview he asked how things could be otherwise when the Chinese had seen foreigners making war on the country, and the irreparable injury which they had inflicted on the whole empire by the importation of opium. If England would consent to interdict this, and cease either to grow it in India, or to allow it to be imported to China, there might be some hopes of more friendly feelings. They were told by Mr. Batten that opium was perfectly harmless, but its utterly demoralising effects were stated in this despatch to be seen in all those who gave way to the vice. He also said that the extension of this pernicious habit was mainly due to the alacrity with which foreigners supplied the poison for their own profit, perfectly regardless of the irreparable injury inflicted, and the Chinese, therefore, naturally felt hostile to all concerned in the trade. He would now give Sir Rutherford Alcock's own opinion, given to a Committee of the House of Commons in 1871. In answer to the question, "Can the physical, moral, commercial, and political evils of this vice be exaggerated?" his answer was, he had no doubt where there was a great amount of evil there was always a certain amount of danger of exaggeration; but, looking to the universality of the belief among the Chinese, that whenever a man took to smoking opium it probably led to the impoverishment and ruin of his family—the popular feeling which was universal both amongst those who were addicted to it, who always considered themselves moral criminals, and

amongst those who abstained from it—it was difficult to conclude but that what was heard of it was substantially true, and that it was a source of impoverishment and ruin to families. He also said that it was so far a greater mischief than drink that it did not, by external evidence of effects, expose its victims to the loss of repute, which was the penalty of habitual drunkenness. He understood his time was up, or he should have been glad to show that he did not look on only one side of the question. He fully admitted that we had now brought ourselves into a position of such difficulty, through having encouraged and tolerated this trade for 100 years, that probably it was beyond the power of man to suddenly stop it; and any action to be taken now must be made gradually. He did not commit himself to the propositions of the Anti-Opium Society, though he had the greatest respect for it; but, looking at it from the point of view of a politician and a practical man, he thought that violent and sudden remedies were hardly practicable. He believed that, if the British nation thoroughly came to understand the evil which had been wrought in time past, it would insist on demanding a policy which should point towards the gradual extinction of the trade; and he hoped that view would be taken up by members of the Society.

Sir THOMAS WADE, G.C.M.G., K.C.B., said he felt much the same difficulty as the last speaker had admitted. The subject was so enormous that it was exceedingly difficult to deal with it, but he had had the advantage of reading the paper beforehand, and almost flattered himself he should not be called upon, because it so satisfactorily stated most of the grounds upon which he was opposed to the extreme measures suggested by the Anti-Opium Society. In a book—which he had been reading with intense pleasure—viz., the Chairman's work on the Rohilla war, he, the Chairman, remarked with regret upon the tendency to be noticed amongst Englishmen of disparaging their own countrymen. Now we are face to face in this opium question with an undoubted evil. He had a thorough respect for the sincerity with which the majority of the gentlemen composing the Anti-Opium Society attacked the question, but he deplored the unfairness of their arguments and the misrepresentation and misapplication of historical statements which they made. He did not expect that Mr. Smith would have furnished him with so many weapons as he had. In the first place, he quoted at considerable length a statement of his own, extracted from certain words of his which were supposed to have contained an admission that England had forced the opium traffic on the Chinese. Those expressions referred to the unwillingness with which they had made every concession. It was in a very lengthy memorandum prepared, at the desire of Lord Clarendon when Sir Rutherford Alcock was negotiating a revision of the Treaty in 1868. Amongst the numerous proposals submitted to Sir Rutherford Alcock from all the Chambers of Commerce at the ports, there was, amongst a large number of addresses and propositions, upon almost every conceivable subject, a proposition—not at all an unnatural one—that, instead of being confined to the ports we should be allowed to carry our goods inland and establish ourselves at commercial centres in the interior. He (Sir T. Wade) opposed that, because it was not safe to put British merchants and their goods in places where they could not be protected. Why? Because experience showed that they could not as yet trust the feeling of the Chinese, seeing that whatever we had got from them was the result of war. That he admitted. Those first lamentable hostilities from 1839 to 1842 might indeed be called an opium war, because the great act with which they were connected was the destruction of an enormous quantity of opium, for which and for a great deal of other property an indemnity was ultimately claimed; but the same thing would have been done with any Power that England was not afraid to fight, and it was no use to overlook the whole of the antecedent history of our connection with China. That dated from 1720, when the Great Emperor, the second of the line that was then ruling, established the Guild known as the Hong merchants, to superintend trade. Reading the record of what was imposed on English merchants for more than a century, the cruelty and barbarity to individuals, and the humiliating insults inflicted, it was not to be wondered at that we did at last come into serious collision with them. It was a fact that, without a resort to arms, an understanding with the Chinese was then impossible. Thus it was that we came to loggerheads with them at all in 1839. Now, as to the evil that opium had inflicted on individuals, he had seen as much as others had; but he had lived to learn that the evil was not, as he supposed, when he wrote the words just quoted, ineradicable, neither was he justified in impeaching it as an evil without mitigation. Although it was within his ken that there was an enormous amount of mischief inflicted, as there was, by gin and alcoholic excesses, he had lived to perceive that a large number of people took it as Englishman took a glass or a cigar. It had become with the class above that which smoked opium when he first went to China, what the better class of wines had become with us. But, to return, at the time we were charged with having forced the opium trade on China; negotiation with China on the subject was absolutely impossible. If it had been possible, there would have been no war. If it had been, there would have been long ago a mitigation of our trade in opium, which would have removed that reproach from us. As to the extent of our responsibility, could it be supposed that the little quantity of opium—he was indebted to Mr. Smith for his 200 chests—imported into China in the last century could affect a whole nation whose territory was something like 1,200 miles square? What happened with that 200 chests? Was the objection on the part of the Government to opium-smoking in

China such that even that Indian supply was prohibited, except for medicinal purposes? What were the Chinese smoking all that time? When he first went to China, fifty years ago, it was to witness the last act of that wretched war, because it was wretched to fight those who could not stand against you; but, as he had said, war was forced upon us. There was no room for negociation. Had there been, with a man as conciliatory as Captain Elliot, there would not have been that appeal to India to send a force to protect our people. What did the Chinese authorities do? They cut off supplies, seized the property of Englishmen, and destroyed it. A gentleman says it was contraband. Be it so, but it was not because it was contraband that it was destroyed. The Chinese were carrying out that hostility and contempt with which they regarded the foreigners, and there was no possibility of dealing with the Chinese except by a strong arm, and that was the real cause of the first war. He knew it was no use repeating this, because he said it on the memorable occasion to which Mr. Smith had referred, and then he came to him afterwards, and talked about the second opium war as if he had never spoken of any history at all. The history of the importation of the drug had been completely disposed of by Mr. Batten. They were accused of forcing it upon the country, but of all the foreign ministers England had ever had, there had not been a more belligerent minister than Lord Palmerston. He was at the Foreign-office when Lord Napier was sent out to inaugurate a new state of things on the expiration of the East Indian Company's existence, and in his instructions there was not a word of reference to opium. Then came the collision in the manner he explained, and what were the instructions to Captain Elliot and to Sir Henry Pottinger? Not a word about opium. Sir Henry Pottinger did once, in the course of the negotiations, refer to that question, and Kiying told him he could not enter into it, and as soon as Sir Henry Pottinger returned to Hong Kong, after signing the Treaty, his first idea was to remove all opium from the colony; and if there was to be opium trade at all, let it be at Macao. But it was represented to him that if there was an opium trade at Macao, all trade would be at Macao, and none at Hong Kong, and that we should not benefit the Chinese one iota. In 1846 he (Sir T. Wade) was in civil employ in Hong Kong, and went thoroughly into the question of native production. He ascertained that, at that time, the poppy was grown in ten of the eighteen provinces of China, and that in the north-west province, 3,000 miles from Canton, which up to that time had been the only port accessible to England, opium was made which was said to rival the Indian. A conversation between the minister, Wensiang and Sir Rutherford Alcock had been quoted, in which the former had enlarged on the question of opium, but what did he couple with it? Missionaries. He said, "Save us from opium and missionaries, and then things will go well." He did not mention this to fling a stone at the missionaries. What the Minister Wensiang intended to imply was not condemnation of the strange doctrine taught, or of the zeal of the teachers; but the strife about claims, building sites, &c. Of opium, he had a personal abhorrence, so decided, that when laudanum was prescribed him he refused to take it. A colleague whom he had asssisted to bring forward, was to his intense disgust a confirmed smoker. In the year 1858, when we were at war in connection with the Lorcha Arrow affair, Lord Elgin came out with the conviction that we were all wrong, and that the Chinese were in the right; but he came to hold very different views in the course of the two years he spent in China. Nothing, however, was farther from his intention than to impose upon the Chinese any obligations that would be unfair to them; and in his negotiations at Tien-tsin, which, so far as oral communications are concerned, were carried on entirely through Mr. Horatio Lay, the Commissioner of Customs to the Chinese Government, that gentleman, who was present, could testify that from first to last there was never a word said about opium. There were treaties, signed by ourselves and other Powers, with an understanding that we should negotiate a tariff at Shanghai. That was done, but opium was a complete afterthought, even with reference to the tariff. Who suggested to Lord Elgin that he should touch it? The American Minister, who advocated the legalisation of the trade, on account of the irregularities inevitable so long as smuggling continued.

The Rev. F. Storrs-Turner said Lord Elgin was instructed by the Earl of Clarendon, when he went out to China, in the first instance, to get the opium trade legalised.

Sir Thomas Wade accepted the correction, but he maintained that what, to his certain knowledge, stirred Lord Elgin to take the action he did came from the American Minister. But what reference had either of the two latest collisions to opium. The quarrel in both cases was perfectly independent of it. England was forced to fire the first shot—the Chinese are careful always to avoid taking the initiative — but when people talked about injustice to China, no allowance was made for the provocation which England had received. Now as to the reform of the opium smoker, Sir Thomas Wade held in his hand a set of memoranda of interviews he had with the Chinese when he was endeavouring to get the opium taxation settled. He would read one of an interview on the 16th January, 1881. As regarded opium, certain points had been suggesting themselves to Sir T. Wade, upon which the opinion of the Yamen would be valuable. In the first place, as the Ministers were of course aware, the trade in opium, native and foreign, was regarded in different lights by the high authorities of different provinces, and their mode of action was dissimilar. Some were for stamping out native opium altogether,

and restricting the sale of foreign opium by placing prohibitions on the consumption of it. In other provinces it was regarded as a source of revenue, and the habit of opium-smoking was not checked, but the drug was heavily taxed, the vice being turned to account as a means of enriching the exchequer. As these modes of procedure were diametrically opposite, Sir Thomas Wade would be glad to be informed what was the policy favoured by the Central Government? The Minister addressed replied that the question was not an easy one to answer. He did not think that the Central Government had gone so far as to formulate a policy at all. Speaking from a general point of view, however, he might say that if the habit of opium-smoking could be universally and at once abolished, the Chinese Government would be ready and willing to sacrifice the revenue that was at present derived from opium. All sensible men were nevertheless agreed that this was an impossibility. The habit of opium-smoking was beyond the reach of prohibition, and the idea was how to turn it to account. The only way in which it could be turned to account was by making it a source of revenue, and the revenue thus derived was indispensable. There were, moreover, so many other matters that needed reform before the opium question was taken in hand, that it might safely be said that the abolition of opium had not entered the minds of those entrusted with the government of the Empire. Sir T. Wade went on to say that many persons, notably the foreign missionaries in China, had been urging on the British Government through various channels the advisability and the equity of abandoning their connection with opium. Suppose, for as yet it was a pure supposition, that the British Government were eventually to effect a gradual diminution of the opium trade from India, by limiting the import to an increasing degree, year by year, until the trade was abolished altogether, did the Minister think that such an arrangement would meet with the approval of the Chinese Government? The Minister addressed, who again protested that the question was a difficult one to answer, replied that in his opinion such a plan would be useless. As long as the habit existed, opium would be procured somehow, and if it did not come from India it would be procured elsewhere. Any serious attempt to check the evil must originate with individuals. As long as men wanted to smoke and insisted on smoking, they would smoke, and a spontaneous abandonment of the habit on the part of the people would regulate the supply. Nothing short of this would do any good, and philanthropic efforts to check the evil in the manner suggested by Sir T. Wade would affect the revenue only, without in any way reaching the root of the mischief. That was all that he, Sir Thomas Wade, contended. There was a remedy. Nothing, he believed, would eradicate what was mischievous but the reform of the individual, and nothing but the evangelisation of China would produce the reformation of the individual necessary to accomplish that reform. He said that to the Anti-Opium Society, and to everyone else interested in the task of evangelisation; but for the purpose of evangelising China they must go to work in another way. We had not been sending to China the class of men that would influence the literary class who represents the mind of the country, and until we sent people competent by education to place themselves on a level with the literary men of the country, and to speak to them in a way that would induce them to believe that we also were scholars, it would be impossible to introduce Western views, either theological, educated, moral, or, which with the Chinese was the same, political, any more than could we attempt to protestantise Ireland without first having converted the priests.

Mr. HORATIO N. LAY, C.B., said that he must premise that opium was introduced into China, under the name *afuyung*, from Persia, Syria, and Turkey, as far back as the 8th century. We were, therefore, not responsible for imparting to the Chinese their taste for opium. Its import continued for centuries, and, in the year 1722, it was formally legalised by the Chinese Government, entered in the tariff as a dutiable article, paying £1 sterling per picul of 133⅓ lbs. The duty was directed to be received at Canton, through the Hong merchants, in exchange for tea and silk. As our first Embassy (Earl Macartney's) did not proceed to Pekin till 1792, it cannot be affirmed that the legalisation of the article was not the spontaneous act of the Chinese Government. Legislation continued for 70 years, during which period the cultivation of the poppy was largely extended in China. In 1799, the Edict of 1722 was cancelled, and importation was forbidden, but nominally only, the import being, as before, openly permitted at Canton—then the only port open to trade—and carefully fostered by the Chinese, the highest officials of the province, and at Pekin, partaking in the gains from the traffic. It was in the reign of the Emperor Keaking, who had cancelled legalisation, that our second Embassy (Lord Amherst's), visited the capital in 1816. In the annals of neither this nor the previous embassy do we find the slightest allusion to opium—no complaint that we had brought it into the country, contrary to the wishes of the Government. Thus we have the facts, which are unimpeachable, that for centuries China admitted opium; and that she, of her own free will, encouraged and stimulated its import by the enactment of 1722, which was suffered to continue in force down to 1839, a period of 117 years. On the dissolution of the East India Company, Lord Napier was sent out, in 1834, to be H.M. Superintendent of Trade. He proceeded to Canton to present his credentials, but the Chinese declined to receive him or his credentials. If he had anything to say, he must communicate through the Hong merchants (a guild which had the monopoly of trade with foreigners), or trade would be cut off. He was treated with the utmost indignity, even his baggage chests were broken open, while the keys were within reach;

and when he took his departure in a passage boat for Macao, he was escorted by Chinese soldiers, who kept him for five days upon the river in a broiling sun, upon a passage that could have been accomplished in as many hours. The insulting treatment, joined to the sufferings he endured, induced a fever, from which he died a few days after the boat reached Macao. Sir George Robinson succeeded Lord Napier, and complained of "disgraceful and humiliating annoyances." In 1835, the Viceroy proclaimed eight regulations of trade for the guidance of the foreign community, in in which it is notable that opium was not even mentioned, and Sir George Robinson, at that date, reports the quiet and regular progress of the opium trade. In 1836, Captain Elliott became H.M. representative. He was instructed by Lord Palmerston not to re-open communications through the Hong merchants, but only with the Viceroy or other responsible official. From 1821 there had been a rapid increase in the import of opium. The duty and excessive charges upon woollen and other goods had led to the importation of dollars. The Americans at that time imported dollars and Turkey opium to pay for tea and silk. The difficulty experienced in procuring dollars operated powerfully, wrote one of our merchants in an able letter in the Blue Book, in stimulating the imports of opium, which, together with other imports, being insufficient to pay for the tea, silk, &c., the balance had to be taken in China gold and silver to the extent of 2,000,000 dollars per annum. The fears that China would be drained of her precious metals—the probable cause of the revocation, in 1799, of the legalising edict of 1722—were re-awakened at the court. Conflicting advice was tendered by the highest officials in the empire. Some were in favour of absolute prohibition of opium. Some were in favour of "a return to the former plan," by re-legalising it, and prohibiting the export of gold or silver. The latter counsel was given by the high authorities at Canton, and at first prevailed. Legislation was decided on, and the functionaries there were instructed to make preparatory arrangements accordingly. The Court, however, wavered between re-legislation and prohibition for two years, when the fears that no edicts against the export of silver could be made effectual prevailed, and prohibitory measures against opium were the final decision. Such is the purport of all the Chinese State papers, of Lin's letter to the merchants, and not a word from first to last is there about our having forced, or having conceived a purpose to force, China to receive opium. When Captain Elliott apprised Lord Palmerston that there were indications of a purpose on the part of the Chinese Government to stop the importation of opium, Lord Palmerston wrote as follows:—"June 15th, 1838.—Her Majesty's Government cannot interfere for the purpose of enabling British subjects to violate the laws of the country in which they reside; any loss, therefore, which such persons may suffer in consequence of the more effectual execution of the Chinese laws on this subject, must be borne by the parties who have brought that upon themselves by their own acts." Is there any trace here of forcing opium on the Chinese? There can be but one answer. Lord Palmerston had repeated in 1837 his instructions to Captain Elliott as to communicating only with the Viceroy or other responsible authority, but the Viceroy declined to receive any letters from Elliott unless the word "petition" were used. Captain Elliott, therefore, broke off communication with the Viceroy towards the end of that year. Matters continued in this state until early in March, 1839, when Commissioner Lin suddenly appeared on the scene, armed with special powers to put down the opium traffic. Ignoring Captain Elliott, he addresses the foreign merchants direct, commanding them to deliver up to him all opium in their possession. At the same time, he surrounds the English factories with soldiers, takes away all the native servants, and cuts off all provisions, and holds Captain Elliott and the 200 merchants as his prisoners within the factories. Captain Elliott proposes to give Lin an order for the delivery to him of all the opium on board the receiving ships. Lin answers that if in three days his "commands" are not complied with, the fresh water shall be cut off, in three days more all provisions shall be utterly cut off, and a further delay of three days will involve the death penalty to all. Captain Elliott complies, and sends Lin an order to receive 20,283 chests within the time named. Lin receives the opium, but does not release H.M.'s representative according to promise, but retains him a prisoner, along with the merchants, for a period of seven weeks. Is any word uttered by H.M.'s Minister about compensation for the opium thus delivered up? None; and nothing about our having forced it on the Chinese by Lin. Reporting the circumstances to Lord Palmerston, Captain Elliott wrote:—"The utmost conceivable encouragement, direct and indirect, on the one hand, and sudden violent spoliation on the other, are the characteristics of the Chinese measures concerning opium. It has been a confusion of terms to call the opium trade a smuggling trade; it was a formally prohibited trade, but there was no part of the trade in this country which had the same active support of the local authorities. It commenced, and has subsisted by means of the hearty connivance of the mandarins; and it could have done neither the one nor the other without their constant countenance." In his remonstrance to Lin on his bad faith as to his release from imprisonment, Elliott tells Lin the unpalatable truth, that "the traffic in opium has been chiefly encouraged and protected by the highest officers in the Empire, and that no portion of the trade had paid its fees with so much regularity as this of opium." Lin answered the protest, not by a denial of its truth, nor by complaint that we had brought opium in defiance of Chinese law, but by moving down towards Macao, where Captain Elliott had taken up his quarters, with 2,000 troops, and by issuing orders that Captain Elliott's servants should

be again withdrawn, and that all supplies to British merchants at Macao should be stopped, with the result that Elliott was obliged to quit Macao, and take refuge on board H.M.S. *Volage* at Hong Kong, disregarding a further demand from Lin that a British subject should be handed over to him for punishment, and that the British merchant vessels who, in consequence of his violent methods, had repaired to Macao, should be required to re-enter the Canton river. Lin had ruined the trade and wanted to restore it, while he had lost all control of the opium traffic. Lin expelled British merchants from Macao, then cut off all supplies to Hong Kong, and directed the water to be poisoned. He commanded the people to fire upon and seize any British subject found on shore purchasing provisions, and some of our people were cut off. And what was Captain Elliott's rejoinder to all this? He offered the other cheek for Lin to smite. Closing his eyes to what had transpired, he proposed to renew official relations with the authorites from Macao. On the 24th of September we find him actually submitting to Lin an offer to concert measures for the prevention of the import of opium in British vessels, and making detailed propositions. And how is this meek attitude treated by Lin? With scornful disregard—a fine object lesson for all time. On the 9th of October H.M. Representative perseveres in appeals to Lin:—"His wishes had been carried out in all respects, the time may have come for British subjects to be permitted to return to Macao." No word throughout, be it noted, on the part of Captain Elliott or of Lord Palmerston, as to compensation for the opium taken by *force majeure*, without any previous notice from the Chinese Government of its change of policy; nor on the part of Lin as to our having imported opium contrary to the wishes of the Government. Lin was bent on war, and, by way of reply to the last communication, ordered attacks upon English vessels; and several British subjects were wounded or killed. In one case, a passenger was left for dead, barbarously wounded, with his ears cut off and stuffed into his mouth. Finally, Lin crowned all his proceedings by issuing a proclamation, which amounted to a declaration of war, declaring trade at an end with Great Britain, and forbidding, after December 9, 1839, the importation of British goods under any other flag. This declaration being issued, too, nine months after the surrender of the opium, after the special offers of the British Minister to cement measures for the suppression of the opium trade in British ships, and after the repeated overtures for the renewal of relations made by Captain Elliot. It was not opium then that produced the war, for Lord Palmerston had already, in 1838, declared his views, and no claim was ever put forward by him for the opium taken possession of by Lin. But war was forced upon us. That left Lord Palmerston no option but to despatch on expedition to China to demand redress. It took two years to bring the Chinese to terms, and though Lord Palmerston made them pay for the opium seized in 1839, so far from taking advantage of the occasion to demand the re-legalisation of opium on the conclusion of the Treaty of Nan-kin, every means was proferred the Chinese Commissioners to control its import, if they so desired. They never so desired, as could be abundanty proved.

Sir Lepel Griffin, K.C.S.I., said he thought the question, whether the war in China arose on account of the opium or not, had not much interest for the people of England at the present moment. In order to counteract the exceedingly mischievous tendencies of the doctrines of the Anti-Opium Society, it was necessary to prove to the people of England, in an easy and simple manner, that the attacks made on opium were both false and foolish: that opium smoked or drunk in a reasonable manner, and not to excess, was not more dangerous than tea or tobacco. When at the head of the Administration of Central India, he was also the Collector of Opium Revenue from the native States, amounting to upwards of £2,000,000 sterling a year; and it had been his duty to study the question, and understand the effect of the cultivation and use of the drug, both from a social and fiscal point of view. He thought its ordinary and moderate use to be healthy, and, as a judge, he had never known a crime occasioned by its use. Could the same thing be said in England with regard to the the use of alcohol? The majority of the Rajputs in Central India ate opium—at least, it was the custom of the country. In the other part of India in which the greater part of his service had been spent, the Punjaub, the Sikhs were large consumers of opium, and they were physically, morally, and mentally, the two finest races in India. Gentlemen might smile and hold up official Blue-books, but the Sikhs and Rajputs, who were the opium consumers of India—excluding the population of the Delta, who took it for medical reasons—were the finest races in the continent. He found that persons who defended temperance were the most intemperate; they would neither listen to argument nor allow other people to say a word in defence of opinions opposed to their own. Opium-smoking was not a common habit in India, where it was ordinarily drunk, but smoking was less injurious than drinking it. With reference to the exclusion of opium land from grain cultivation, of which they had heard so much, Malwa, the province of Central India, in which all the best opium land lay, was the only part of India he knew in which, throughout historical times, there had been no famine. He could not but observe that it was an astonishingly sad thing to see, in the latter part of the 19th century, a society possessed of such mischievous, homicidal characteristics as the Anti-Opium Society. If their convictions were to prevail, they would rank as destroyers of the human race with cholera and famine, because a very large part

of the population of India—especially that inhabiting the fever-stricken malarious districts of Bengal—was only preserved from death by the habitual use of opium. That was known to every person of any authority in the room.

Mr. J. G. ALEXANDER, LL.B. (Secretary of the Society for the Suppression of the Opium Trade), said Mr. Batten began by speaking about trade, and there seemed to be an assumption underlying that part of his paper that every trade that brought money to a country must necessarily be beneficial. That was not so; a trade which flourished on the impoverishment of another country could not but be detrimental. He believed this trade was really detrimental to India and Great Britain, because it was the means of impoverishing the Chinese people. It did them no good, but dried up the sources of trade with China, and therefore must necessarily be an economic blunder. For the purposes of this argument, he was assuming that opium was, as there was overwhelming evidence to show that it was, a great curse in China. It was also assumed in that part of the paper that the land devoted to the cultivation of the poppy could not be used for any other purpose; but only two or three years ago, a Commission was appointed by the Government of India to inquire why it was that the ryots in the poppy-producing districts were not willing to extend the cultivation of the poppy, and that the area was diminishing. It was reported that there were three articles competing with the poppy—potatoes, cotton, and sugar. The poppy was grown on the very finest and richest land, which might be applied for the production of other articles which, instead of impoverishing the world, would enrich it. Something was said about the superior quality of the opium supplied from India in preference to that of China, but that superior quality consisted in having more intoxicating and deleterious power. In the reports which Sir Robert Hart collected, some ten years ago, several Consuls showed that it required a greater quantity of native opium to intoxicate, and therefore it did not do so much harm as the Indian. He therefore failed to see any force in the suggestion that the Indian opium was superior. Then there was the question raised. Could smuggling be prevented? With regard to that he would appeal to the reports from Burma. Several of the officials from Burma, who had given evidence on the subject, said that it could be dealt with, and Sir Charles Aitchison himself said, in his Memorandum of 1881:—"Already the price of opium is artificially forced up to the maximum, presenting the very strongest temptation to the smuggler. The pecuniary temptation cannot become much greater than it is if opium were altogether forbidden, and we should have the sympathies of the people with us in the suppression of smuggling." Mr. Batten quoted a report dealing with Assam, in a recent Blue-book, but he had a striking piece of evidence to the contrary effect. Mr. C. A. Bruce, the superintendent to the British Government of the tea plantations in Assam, said the British Government would confer a lasting blessing on the Assamese and new settlers if immediate and active measures were taken to put down the cultivation of opium and stop its importation; that if something of this kind were not done, and measures soon taken in consequence of this report, thousands about to immigrate would be affected by the opium mania—that dreadful plague which had depopulated this beautiful country and turned it into a land of wild beasts, and degenerated the Assamese—a very fine race of people—into the most abject, servile, crafty, and demoralised race in India.

Dr. MOUAT said that was utterly untrue; he spoke from personal knowledge.

Mr. ALEXANDER said Mr. Bruce went on to say would it not be the highest blessing if a humane Government stopped these evils with a single dash of the pen and saved Assam? He made these quotations from Lord Justice Fry's book; facts and evidence that was exactly similar to the evidence from Burmah. Mr. Batten had summed up that evidence on the one side in a contemptuous sentence or two, but if they would look at the Blue-book, they would find the evidence from Burmah against opium was overwhelming. The Government of India acknowledged it to be "the unanimous opinion of respectable Burmans, and official and non-official Europeans, that the use of opium by Burmese was deleterious and harmful in a special degree."

Mr. BATTEN said that was only an opinion; there was no fact quoted, and not a single instance of a Burman being hurt by opium.

Mr. ALEXANDER said was it to be supposed that the whole Burmese people, the whole of the officials and the whole of the respectable Europeans resident in Burmah, formed such an opinion without any facts? And the same with the whole body of missionaries in China. With one single exception, which had been quoted, there was a practically unanimous opinion of the missionaries, including many medical missionaries—many of the ablest men who had gone forth into the mission-field—that opium was an unmitigated curse to the Chinese. As Archdeacon Moule said—What interest had the missionaries in decrying their country? They were as much patriots as other men; but they were met with this question at every step. He saw before him a medical missionary who could testify to that. Wherever they went, in most parts of China, they were met with the cry, "You brought opium here, and do you come and preach religion?" Sir Charles Aitchison's memorandum was based on facts; naturally officials would speak of their knowledge, not what they had seen. A circular was issued instructing Commissioners to obtain the opinion of district officers and educated and intelligent natives on the question of the increase of opium-smoking amongst the Burmese, and submit

any remedial measures of a practical kind; and a little further on he said the papers submitted presented a painful picture of the demoralisation and misery produced by this habit. The responsible officers in all parts of the country bore testimony to it. That was ten years ago, and to-day the Indian Government said it was the unanimous opinion of respectable Burmans, and officials, and non-official European residents. Would it be any better if they mentioned a case here and there? The reply would then be made, "You have picked out isolated cases." These were the conclusions drawn from a very large number of facts and observations. As regards the question whether there was an ancient use of opium in China, he would only say that his friend, Professor Legge, said there was no evidence of it that he was aware of in the early works of China. Mr. Batten had referred to one extract, which he did not read, to prove that the intoxicating properties of opium were well known in China 300 or 400 years ago, but he thought it showed nothing of the kind. That was the only extract brought forward until about 200 years ago, when, undoubtedly, the fashion was introduced, probably from Java. That England was the first to introduce opium into China, and that smoking was absolutely unknown before the English had to do with the trade, was not a contention that his society had ever been responsible for. They admitted that it existed on a small scale; the taste was already created to a limited extent, but that was all. With regard to the Roman Catholic missionaries, up to the end of the last century there was no trace of it to be found in their works.

Mr. BATTEN—Nor now.

Mr. ALEXANDER said he had certainly seen statements from Roman Catholic priests to this effect; he had seen one from the "Weekly Register" only a year or two ago, which was put into the "Friend of China," and the late Cardinal Manning used to say that the Roman Catholic missionaries gave exactly the same evidence as the Protestant missionaries as to the prevalence of the habit throughout China. Why did the Government of China entertain this pious opinion, as Mr. Batten called it? What was the foundation of it? It was a remarkable fact that among all the testimonies collected there was not one bit of evidence quoted from a Chinaman in support of the drug. The Rev. F. W. Baller, who had travelled in 13 out of the 18 provinces of China, and amongst all classes, said he had never found a Chinaman—least of all those who smoked opium themselves—prepared to defend the habit. Whence did that delusion on their part arise, if it were really so beneficial as their Indian friends said? Throughout China the Christian missionaries did not admit opium smokers into their churches. He would conclude by saying that the undoubted blunder in the memorial, which had been made so much of, rose from the accident (for which he was personally responsible of two sentences, one relating to Lahore and the other to Lucknow, being transposed. There were some gentlemen who knew India exceedingly well, in the society, and amongst those who signed the memorial was the venerable Sir Arthur Cotton.

[Mr. Alexander has sent the following addition to his remarks at the meeting:—In Mr. Batten's paper he quoted the evidence of Mr. Brereton, and told us that "he was in no way engaged in the opium trade, and had no pecuniary interest in it." At page seven of "The Truth about Opium," Mr. Brereton says: "I have been the professional adviser of the opium farmer" (*sc.* at Hong Kong) "for at least ten years, and from him and his assistants I have had excellent opportunities of learning the truth about opium." Would it be correct to say of the solicitor to a great distillery company that he had "no pecuniary interest" in the trade? and would his testimony as to the absolutely innocuous effects o whiskey drinking be accepted as w olly disinterested (2) Mr. Batten argues that the effect of abolishing the opium trade would be to cause a still greater fall in exchange, because China is paid by Indian opium for the excess of her exports to England. I submit that the contrary would be the effect. At present the opium trade causes a drain of silver from China to India (see my "Substitutes for the Opium Revenues," p. 25). If the import of opium into China ceased, China would have to take payment for that portion of her exports which is now paid for by opium from India, either in goods or in money; doubtless she would take it partly in cach. Thus, instead of exporting silver, as at present, she would absorb silver; for "India and China are now the only countries that freely coin or absorb silver" (Memorandum on the administration of India during the past thirty years: presented to Parliament, 1889, c. 5713). The tendency would, inevitably, be to counteract powerfully the steady fall in the price of silver, that has so long embarrassed the Indian Government and the commerce of the East. The greater demand for British and Indian produce would also stimulate Eastern trade. (3) The quotation from my pamphlet, "India's Opium Revenue," no longer represents the extent of the society's aims. Since that pamphlet was written the society has advanced its programme, which now includes the immediate stoppage of the export of opium from the native States of Central India, on terms to be equitably arranged with these States Their share in the profits of poppy cultivation has been reduced by Chinese competition, and the consequent fall in prices, to so very small an amount that this would form no appreciable addition to the cost. It would doubtless be far less costly, quite as easy, and much more satisfactory, to arrange with the native chiefs for the suppression of the poppy culture in their territories, than to establish a Customs barrier around them. (4) Mr. Lay quoted the statement made in 1836 by the Chinese

Governor of the two Kwang Provinces, that from 1723 to 1795 there was no regulation against purchasing or inhaling opium. This statement, however, is contradicted (as was pointed out by Mr. Gillett at the meeting) by the admissions made on the trial of Warren Hastings. It is also at variance with the letter from Mr. Fizmagh, printed in the House of Commons Committee's report of 1783, which states that "the importation of opium to China is forbidden on very severe penalties. The opium on seizure is burnt, the vessel in which it is brought to the port is confiscated, and the Chinese in whose possession it is found for sale is punishable with death." Dr. Edkins' Yellow-book on the "History of Opium in China," has cleared up the matter by showing that in 1729 an edict was issued making the opium trade unlawful. Dr. Dudgeon, however, from whom Dr. Edkins obtained the materials for that part of his treatise, informs me that the latter has not stated the facts quite accurately; the decree of 1729 only applied to the island of Formosa, and it was not till a few years later (about 1735), that the first general decree, prohibiting the trade throughout China, was issued. From that time till 1858 it remained unlawful.]

Sir GEORGE BIRDWOOD said that the Chairman would have called upon him to speak, but it was too late then for any further speeches, and that his own remarks, and those of any gentlemen who had sent in their names, would be printed in the *Journal*.

The CHAIRMAN said there was no time for him to offer any oral remarks of his own, and he would simply conclude the meeting by proposing a vote, which he was sure they would all concur in, of thanks to Mr. Batten for his very interesting paper.

The proposition was carried unanimously, and the proceedings terminated.

Sir JOHN STRACHEY, the Chairman, has communicated the following remarks, which he would have made at the meeting, had there been time:—In my own opinion, no more able and complete and accurate account of all the more important facts of the case has ever been given to the world than is given in Mr. Batten's interesting paper. I only wish it were possible to think that the truths Mr. Batten has told could receive as wide a diffusion in this country as that which has been given to the errors and misstatements, as I believe them to be, which are scattered broadcast over the land. I must say something of my own experience on this subject. I passed some thirty-eight years of my life in India, and I should not be very greatly exaggerating if I were to say that, during that time, I held almost every office which a member of the Civil Service in India can hold, beginning from offices of little importance, to the very highest posts in the service of the State. I was brought into personal communication with all classes, from the greatest princes to the humblest ryots. I am entitled to say that I can speak with some knowledge of the facts, as they regard the people of India, and the policy of the Government. Now, I have always felt in regard to this controversy that the object to be aimed at is to learn the truth, and to act upon it. Thousands of excellent people in this country, of whom I desire to speak with all respect, because although I know them to be mistaken, I must fully recognise the perfect honesty and nobility of their aims, believe that we are ruining with a horrible poison millions of Chinese, and that not content with this iniquity, we are encouraging the consumption of opium among our own subjects in India with similar terrible consequences. If this were true, I should say for my part, that whatever might be the results to the Government or to the people pecuniary, or economical, or political, or otherwise, however difficult or dangerous it might be to find substitutes for the loss that the suppression of opium cultivation in India might entail, there could be no doubt about our duty. I am confident that, when Mr. Batten tells us that the total value of the poppy crops of India exceeds £13,000,000 sterling a year, he understates rather than overstates the fact. I know that all that Sir Lepel Griffin has told us about Sikhs and Rajputs—the most martial races of India—and the political dangers that would follow on the attempt to interfere with the consumption of opium, to which they have been accustomed for centuries, is perfectly true. Nevertheless, if I believed that the Government was committing the abominable iniquity with which it is charged, of demoralising and destroying millions of people, I should say that, whatever be the consequences, this iniquity ought not to be allowed to last for a single day during which we can prevent it. But what are the facts? It is impossible for me now to enter into the evidence on which my conclusions have been based. I can only give the conclusions themselves, which the experience of a lifetime has impressed upon me. I believe it to be proved to demonstration, that opium is not this terrible poison. The vast majority of those who consume it, consume it in moderation, and so consumed there is no one of the stimulants that enter largely into the consumption of the world that is more innocent. I will go further, and say, more beneficial. It is as innocent as the wines of France or Italy are to the people of those countries, or as undoctored beer is to the people of England or Germany. Like all other good gifts of nature it may be abused, but even when this happens, whatever it may be to the individual, it is less harmful to society than the alcohol, which is the curse of our own country. This opium question has two aspects; one, as it concerns the people of India, the other as it concerns the Chinese. As regards the people of India generally, I would ask you first to remember what India is. It is a vast continent as large as the whole of civilised Europe, with a greater population, for it contains

some 280,000,000 of people. It consists of a multitude of countries differing from each other far more widely than the countries of Europe differ among themselves. In some of these countries, as we have been told, and as I shall have again to mention, certain classes of the people have from time immemorial, consumed opium. But these classes constitute, numerically, an absolutely insignificant proportion of the population of India Speaking in general terms, the consumption of opium in India is so infinitesimally small, that I may say, without exaggeration, that no opium question exists at all. We are told, however, that the consumption of opium has been rapidly increasing, and that it has been fostered by our Government. These statements are absolutely baseless. The increase of population under British rule has been enormous; but there is every reason to believe that the consumption of opium in India, under native rule, 150 years ago, was actually greater than it is now. However this may be, and without attempting to go back to times of which we know comparatively little, this at least is certain, that, although the population goes on rapidly increasing, the consumption of opium, instead of increasing, has diminished. It is certainly smaller now than it was, for instance, ten years ago. This has been the result of the policy of the Government of India. By a vigorous system of Excise, it raises the price of opium consistent with the prevention of extensive smuggling, and reduces consumption to a minimum. The sole present danger is that this policy may be carried too far; and some authorities believe that this is already happening. The danger is that by making opium too dear and difficult to obtain, we may not only encourage smuggling, a comparatively small evil, but may cause people who have been content with the moderate use of opium to have recourse to cheap and noxious stimulants procurable from weeds which, I may almost say, grow near every man's door. Although, as I have said, the consumption of opium by the people of India generally is infinitesimally small, it has been consumed for centuries by certain classes in Northern India. It is an indisputable fact, as Sir Lepel Griffin has told us, that these classes, especially the Rajputs and Sikhs, are precisely the finest races physically in all India. I have often thought that the best practical answer to those who inveigh against the use of opium would be, if such a thing were practicable, to bring one of our crack opium-drinking Sikh regiments to London, and exhibit them in Hyde-park. There is no more vigorous, manly, handsome race of men to be found, not only in India, but in the world. They are the flower of our Indian army, and one of the bulwarks of our empire, and yet the use of opium among them is almost universal. It has always seemed to me a significant fact that among all the passionate appeals to British ignorance, we never hear one word about the Sikhs. We hear a great deal about so-called opium dens, which, after all, are very few and far between, but we hear nothing about the constant consumption of opium among the finest populations of India. People talk glibly about suppressing by law the growth and consumption of opium in India. I have great faith in the power of folly and ignorance, but I trust that I may not see the day when the attempt is made to deprive Sikhs and Rajputs of—I will not say a luxury —but one of the innocent and beneficial necessaries of their lives. I read the other day, referring to this subject, some remarks by a most accomplished writer, who speaks on Indian subjects with high authority—I hope Sir William Hunter will pardon me for quoting him. He said that a law such as that to which I have just referred, could only be enforced in British territories by bloodshed and arms, while in native States it could not be enforced at all. I might enlarge much more on such considerations. They involve issues of political gravity, the existence of which appears to be unknown and unsuspected in this country. I repeat, however, that these classes which consume opium, highly important as they are politically, are numerically an insignificant fraction of the Indian population, and that, so far as the people of India generally are concerned, no opium question really exists. I must now say something about China; but Mr. Batten and other gentlemen, who have spoken with the highest authority, have said so much on this part of the subject, that I shall add very little, and I can add really nothing that is new. There can be no greater delusion than to suppose that China depends on India for her supply of opium. If no opium were exported from India, the consumption of China would remain practically unchanged. Indian opium in China is a luxury of the comparatively rich. If they were deprived of it, they would suffer as the richer classes would suffer here if they were deprived of the choicest vintages of Bordeaux and Burgundy, or if tobacco smokers got no more cigars from Cuba. In such a case, in this country, the frequenters of beer-shops and gin-palaces would be conscious of no hardship; and the population of China would be equally unconscious if it received no opium from India. A single province of China produces more opium than the whole Indian Empire. Whole provinces are covered with the poppy; the cultivation goes on increasing, without any interference on the part of the Government of China. Even, therefore, if it were true that the people of China are being ruined by opium, the cessation of imports from India would not diminish the evil. But it is certainly not true. The vast majority of the consumers of opium in China consume it in moderation; and it is, as I said before, as harmless as the wine and beer of Europe. Moreover, as Mr. Batten has told us, if the Government of China should wish to undertake the task of stopping the consumption of opium, and preventing the importation of opium from India, it can do so if it pleases. It can prohibit the importation, or can impose any restrictions that it likes.

Meanwhile, there is nothing with which we need reproach ourselves. If, as I wrote myself some years ago, in deference to ignorant prejudices, India is deprived of the revenues which she now obtains from opium, an act of folly and injustice will be perpetrated as gross as any that has ever been inflicted by a foreign Government on a subject nation. India now possesses the rare fortune of obtaining from one of her native products a great revenue, without the imposition of taxes on her own people; and we are asked to sacrifice the manifest and vital interests of those people, to whose good we are pledged by the highest duties, in hope of protecting others, against their will, from imaginary evils; in other words, to inflict certain injury in pursuit of a benevolent chimera, which must elude us. Truly, to use the words of Condorcet, "L'enthousiaste ignorant est la plus terrible des bêtes féroces." I wish to say only one thing more, and it is that with which I began: what we want is the truth. How, I may be asked, if this widely-spread belief regarding India is erroneous, what is the explanation of its prevalence? My answer is, that the ignorance that prevails in this country regarding everything Indian is enormous. The ignorance about opium is on all fours with the ignorance on every other subject connected with India, and this ignorance is not confined to those who we expect to be ignorant, but extends to the most highly educated classes. It extends to all Indian subjects, history, geography, the condition and habits of the people, the constitution of the Government, in fact to everything. I will give an illustration which always seems to me to have an useful bearing on this opium question. There are many curious delusions about India which it seems impossible to kill. When I hear educated Englishmen talking about opium, I am often reminded of some admirable remarks of Sir Henry Maine on Mr. Buckle's "History of Civilisation." Mr. Buckle derives all the distinctive institutions of India, and the peculiarities of its people, from the fact that the exclusive food of the natives of India is rice. It follows from this, he tells us, that caste prevails, that oppression is rife, that rents are high, and that customs and law are stereotyped. I have no doubt that if Mr. Buckle had been asked he would have said that the same cause accounted for the consumption of opium in India. I sometimes ask my English friends when they talk about opium what they suppose to be the ordinary food of the people of India. The almost universal answer given, perhaps with some air of displeasure that they should be asked such a foolish question, is that of course it is rice. I believe that nine-tenths of the educated men and women of this country believe this to be true. When they have not learnt such an elementary fact as this, that throughout the greater part of India rice is no more the ordinary food of the people than it is in England, how can we be surprised if they do not know the truth about opium. I cannot pretend to be hopeful that this ignorance will be dispelled before it has inflicted some ruinous injustice on the unfortunate people of India. In conclusion, I would ask those who have accepted these views about the iniquity of the Indian Government in regard to opium, to ponder the words of a wise and benevolent man—John Stuart Mill. He had better means of knowledge and knew more about India than almost any Englishman that I have heard of who had not lived long in that country, and he declared his conviction that our Government there had been "not only one of the purest Governments in intention, but one of the most beneficent in act ever known among mankind." This was true when it was written, and it is truer now. I believe that there is no Government in the world that strives so honestly and resolutely to think of nothing but the highest interests of the people it governs. I believe that there is no country in the world in which the men who carry on the administration are more able and upright, or who have a more true regard for the welfare of those committed to their care. We, who have spent our lives in India, are not all fools or impostors. It is, as Mr. Batten has most truly observed, remarkable that no single instance can be quoted of an Englishman who has been directly responsible for the well-being of India, and who has had an important voice in its administration, who has held the views against which I have been protesting. That, as Mr. Batten said, has been left for irresponsible persons in this country, whose want of knowledge is patent to every one who has studied the question on the spot. When I hear the Government of India, charged with the abominable wickedness of poisoning its own subjects, and poisoning millions of Chinese for the sake of filthy lucre, there is only one reason which prevents me from being filled with indignation, and this is that I know that these charges are the offspring of ignorance alone. Unfortunately this does not make them less serious, for of all the enemies to human progress ignorance is the most formidable, and is especially formidable when, as in this present case, it is combined with honest enthusiasm and an anxious desire for that which is right.

The following communications from gentlemen who sent up their names, and were prepared to speak, have been received since the meeting:—

Sir GEORGE BIRDWOOD—I have already said all that I have to say on the only phases of the opium question that interest me, namely, the historical and physiological, in my letters to the *Times* of the 6th December, 1881, and 20th January, 1882; which have moreover been reprinted at length in Mr. Brereton's "Truth about Opium," and Mr. Sultzberger's "All about Opium," and are repeatedly referred to in Mr. Haines's "Vindication of England's Policy with regard to the Opium Trade," a most scholarly volume, which ought to be in the hands of every serious student of the history of the state monopoly of the production of opium in India. My experience of the habitual use

of opium, and the results of my researches into its origin and spread throughout the East are, therefore, on easily accessible record; and were the controversy on the subject scientifically conducted they would require no reiteration here. But as a paid agitation against the opium revenue is again being organised for the express purpose of making its abolition a test question for Parliamentary candidates at the next general election, it becomes the duty of everyone familiar with India and the condition of its ancient people, to testify, whenever and wherever challenged to do so, to the truth in regard to their indulgence in opium, and its effects on them. But before I proceed to briefly re-state my personal experience of the habitual use of opium in the East, which is the only part of my contribution to the discussion on Mr. George Batten's powerful paper of any practical pertinence to the immediate controversy, I would venture to indulge myself in treating for awhile of certain points connected with the ancient history of opium, of deep suggestiveness to students of the history of Eastern commerce and art. It has always been accepted that the word opium is the Greek word *opion*, the diminutive of *opos*, "juice;" and there is not an Eastern or Western word for true opium which is not a variant of this Greek word *opion*. It has, however, recently been suggested that the Sanskrit word *ahipana*, or *apana*, is an original and indigenous Indian word for opium, and, inasmuch as Pliny mentions [xx, 76-80] a spurious opium-yielding poppy called *aphron* ["foam;" *cf.* Aphro-dite *ex* Ashteroth], that the Greek word opium may have been from the Sanskrit *ahipana*, which, in ignorance of its true parentage, was fathered on *opos*. But the hard fact is that the word *ahipana*, or *apana*, does not occur in any Sanskrit book until it appears, for the first time, in a Sanskrit dictionary, published about seventy years ago. The Greeks and Romans knew poppies, and opiate preparations from poppies, from the earliest ages of their history, and the *pharmakon nêpenthês*, the praises of which, as a "grief assuaging drug," are so rapturously sung in the Odyssey [iv. 221], was probably the primitive form of the Egyptian opium (*opium Thebaicum*) of a latter date. But it is very doubtful whether the first poppy known to them was the *Popaver somniferum*, from which alone true opium has ever been prepared; and it is most probable that their original opiate poppy, and the original opiate poppies everywhere, were certain species of red poppy, resembling *P. Rhœas*, which, from East to West, dye, in bright blood red, the midsummer fields of Middle Asia and Europe. I believe one of these red poppies of Middle Asia to be the original source of some primitive indigenous opiate preparation in China and India, as distinguished from the true opium introduced into these countries from Egypt, and Asia Minor and Persia, through the intermediation of the Arab traders of the 7th and 8th centuries in the Indian Ocean. The earliest form of opium, expressly described by any Western writer, is the *mekônion* of Theophrastus [d. B.C. 287], an inspissated extract of the whole plant, such as the *pharmakon nêpenthês* probably was, and it is clear from Pliny that this *mekônion*, and similar opiate extracts, were made from a red poppy, as a spurious opium still is in the Himalayas and China, as well as from the true opium poppy, *P. somniferum*, with which the Romans had already become acquainted, when Pliny [A.D. 24-79] wrote. Dioscondes [A.D. 77] is the first to distinguish the opium, prepared from the *kôdeia* or capsule of *P. somniferum*, from *mekônion*, and down to the 15th century "meconium," was still distinguished from true opium, the "opium Thebaicum" of the time. I have not the slightest doubt myself of primitive opium, *i.e.*, *parmakon nêpenthês*, and *mekônion* having originated in Central Asia, the known home of the wild form of *P. somniferum*; and it is very suggestive to note in this connection that the Hebrew word *rosh*, translated in our A.V. of the Bible by "gall" (Deut. xxix. 18, and xxxii. 32-3; Psalms, lxix. 21; and Jeremiah viii. 14, ix. 15, and xxiii. 15; and Lamentations iii. 19) is not "gall," *i.e.*, "bile," but a plant, as is indicated by the Hosea x. 4, where *rosh* is translated "hemlock," and that plant one yielding a nauseously bitter soporific decoction, and, undoubtedly, as every reader of the last text referred to who has travelled in the Holy Land will recognise, the red flowering *P. arenarium*. Also the very word *rosh* recalls the letter "r," in *roia*, the pomegranate; *roias*, "the pomegranate red poppy;" *eruthra*, "ruber," "robigo," *rouge*, and red; and also in the Sanskrit *rudhira*, "blood." In the "Song of Moses" it is evident that the wine of Palestine is contrasted with the accursed beverage, an opiate one as I conceive, of the neighbouring Egyptian and other heathen. With reference to the passage in the Psalms, the Gospel according to St. Matthew says (xxxii. 34) :—"They gave Him vinegar to drink, mingled with gall," the Greek word here meaning bile; and the Gospel according to St. Mark (xv. 23) :—"And gave Him to drink wine mingled with myrrh," that is, with *esmurnesmenon*, which was probably some soporific syrup of myrrh similar to those the Greeks and Romans were in the habit of administering in the form of various portions to numb the sensibility of persons condemned to death. Such probably was the *diacodion* of Pliny, a "brose" prepared by stirring a decoction of 120 heads of the poppy *aphron*, thickened with frankincense and gum acacia, and flavoured with saffron, into one sextarius of raisin wine of Crete. I need add nothing to what Mr. George Batten has said on the modern history of opium; and from the authorities I have cited in the third edition of my "Report on the Old Records of the India-office," and independently quoted in the article on "Opium," recently reprinted as a Parliamentary paper from Dr. George Watt's monumental "Dictionary of the Economic Products of India," it is

now abundantly clear that from the 15th century true opium has been grown and manufactured in India and China, and continuously exported from Western India and Bengal. In India, its production was the monopoly of the Great Mogul, until 1757, when, as one of the fruits of Clive's victory at Plassey, it passed into the hands of the East India Company. This sufficiently disposes of the charge, as Mr. Donald Matheson admitted, in July last, and which every reader of "Robinson Crusoe" (see *St. James's Gazette*, 14th May last) should know to be untrue, that Warren Hastings created the monopoly, and originated the trade in the drug with China. I myself harbour a suspicion that the Chinese have always habitually used some sort of papaverous "opiate." The artistic elaboration of the opium pipe in the extreme west of China, bordering on Burmah and Assam, is to me a direct suggestion of such a suspicion. It may have originated in a pre-existing pipe for smoking some preparation of the hemp plant, which, like the opium poppy, is indigenous to Middle Asia; but it could not have originated, as has been suggested, in the smoking of tobacco, as this plant, which is a native of America, was not introduced into China until the 17th century. And there is the fact of the cultivation in Nepaul, Jammu, and elsewhere in the Himalayas, of a red poppy with black seeds, for the preparation of a crude opium; and that, to the present day, this opium is exported from these States in considerable quantities to the hinter-Chinese provinces of Yarkand, Khoten, and Aksu. And I have the further suspicion that it was the Buddhists who, from the sub-Himalayan cradle of their religion in Eastern Bengal, carried the use of this Himalayan crude opium all over India, and introduced its cultivation, with that of the tea shrub, through the passes of the Himalayas, into the western provinces of China proper. And is not this, probably, the true explanation of the sudden conversion of the whole population of ancient India, except the Rajputs, from the use of various intoxicants to total abstinence from them, ever since the date of the rise of Buddhism in India. In his "Vicissitudes of Aryan Civilisation in India," Mr. M. M. Kunte (Bombay, 1880), has conclusively demonstrated that the Vedic Hindus, like all other Aryan races, were voracious eaters of beef, and inordinate drinkers of wine or beer; and an entire *mandala* of the Rig Veda is devoted to the praise of their favourite intoxicant, *soma*, which probably included beers and wines brewed from various sources, such as the date, vine, &c., flavoured, or perhaps fermented with the twigs of some such plant as the *soma-lata* of modern India, *Sarcostemma brachystigma*. In the Hindu mythology, Indra, beside the other things he personifies, is also the "divine afflatus" produced in him who drinks the "sacred *soma*." Drunkenness has been regarded as of this supernal significance in the primitive faith of all nations, as it still is among savage races. Undoubtedly mankind have, in the mysterious processes of Providence, been greatly indebted to drunkenness as well as to dreams, for many of their most exalted spiritual conceptions, and this is, in part, the explanation of the sacramental position held by strong drinks and other narcotics, such as tobacco, &c., in the religious rites of every country of the world, savage and civilised [cf. Deut. xiv. 26]. At all events in India the whole economy of Hindu life is based on the daily *soma* sacrifice; but ever since the advent of Buddhism the offering of flowers and fruits, and in rare instances the ceremonial drinking of a harmless *soma*, infused from the twigs of *S. brachystigma*, has been substituted for beef and wine, or beer. Only among their chivalrous Rajput leaders, who have always represented the Vedic spirit of Aryan superiority in India did the wine or beer drinking habits of the ancient Hindus survive down to the time of their suburgation by the Mahomedans, when for "the intoxicating cup" they partially substituted the true opium introduced into India by their Mahomedan conquerors. It is evident that this temperance reform was promoted among the Rajputs, by their taking to the opium then received from the Persian Gulf and Egypt; and how could the still more remarkable revolution wrought in ancient India by the Buddhists have been accomplished without the aid of some similar narcotic stimulant; and what was there at hand, saving some crude form of opium; for the Buddhists would no more have tolerated hemp than wine or beer; while, for a vegetarian population, such as the bulk of the Hindus became under the Buddhists, living within the tropics, opium was an absolutely necessary adjuvant to their daily diet. But all this is mere speculation, and I now pass on to speak of my personal observation of the habitual use of opium during my 15 years latter residence in Western India. I paid the closest attention to the subject during the whole of the years I was there, and had every kind of experience in relation to it, having at different periods been in medical charge of the Southern Mahratta Irregular Horse, the 8th Madras Cavalry, the 3rd Bombay Native Infantry, a battery of Artillery, the jail and civil station of Sholapore, and the steam frigate *Ajdaha*. Subsequently, and for the remainder of my service, I was attached to the Jamsetjee Jejeebhoy Hospital, Bombay, and was in succession Professor of Anatomy and Physiology, and of Botany and Materia Medica, at Grant Medical College. I was also a J.P. and visitor of the jails in Bombay, and the year I was sheriff I regularly visited them. Besides this, I was probably more intimately familiar with all classes of the native population than any other European of my generation, while, as an ever active journalist, I was mixed up in almost every discussion of this sort during my time in Bombay. Well, in all the experience, as here precisely detailed, and capable, therefore, of being checked at every point, I thus had of the indigenous life of Western India, I never once met with a single native suffering, or who had ever

suffered, from what is called the excessive use, or from the habitual use of opium; and, excepting cases of accidental or wilful poisoning by opium, I never knew of a single instance of death from its use. And I have never met with anyone who, in his own personal experience, has known a case of death, or of injury to health, from the habitual use of opium as practised by the people of any part of India proper.* So far as I can remember, in the printed tables used in Indian civil and military hospitals for the entry of diseases, there is no column for the "opium habit," nor for "deaths from opium." On the strength of my personal experience, I should be prepared to defy anyone to bring forward from their personal experience a single authentic record of death, or shortened life, from habitual opium eating or drinking in India. If any one can, let him, and the means of verifying his or her statement are always, within the current generation, accessible in India. On the contrary, so far as my experience goes, the healthiest populations of Western India are those distinguished for their, so stigmatised, excessive use of opium. I refer to the people of Gujerat generally, and more particularly to the people of the Kaira district, and also of the neighbouring district of Broach. As to opium smoking, it is, from my experience of it, as innocuous as smoking hay, straw, or stubble. It has not the potency of the mildest tobacco smoking, as judged by my experiments with it on myself. I have, therefore, always presumed that the morphia in "the smokable extract of opium" is all decomposed in the flame of the lamp at which the opium pipe is lighted, before the smoke from it reaches the lungs. This, however, is only a presumption; and, in one case, examined by Professor Attfield, morphia was found in the ashes of an opium-pipe used by a smoker in the East-end of London. But, be this as it may, we find in China, as in India, that nowhere are the native populations so robust, industrious, and thriving as in the principal opium-producing provinces of the Empire. It is enough to refer on this point to the report by Mr. W. Donald Spence, our Acting-Consul at Ichang, published in the Parliamentary Paper, No. 3, of 1882, page 35. Of course, I know the *in terrorem* cases to be seen in the opium dens in Bombay and elsewhere in the East. I well knew the Bombay den kept in my time by a Chinese "gentle convertite" to Christianity. It was the one den in a city with a population second, in the whole British Empire, only to that of London. Yet I never saw more than ten or twelve opium smokers there at any time—poor, lost souls, whose miserable, physical, and moral degradation and depravity it would be impossible for even descriptive reporters and sensational photographers to exaggerate. But who were they? The dregs of the lowest outcasts of the greatest emporium of trade in the Old World outside London, and the sink of all the miscellaneous roving vagabondage of the Indian Ocean. And as for the real causes of their sufferings, I will only here say that, so far as I could ever ascertain, they had nothing to do with the opium-pipe, which seemed to me to be simply the last palliative of their "disnatured torment," until enfranchised of it all by death, which generally overtook these cases of complicated and perverted nympholepsy in from three to nine months. I hold the recipe of the *chandu* sold in the Colbhat den, and it is difficult to understand how, when decomposed in the opium lamp, the stuff could have the slightest physiological effect on its smokers. I am not entitled to discuss the administrative and economical sides of the opium question; but surely those who hold that the habitual use of opium is harmful, should be the last to object to the State monopoly of the production of the drug in India. I, on the contrary, holding that its habitual consumption is essential to the health, wealth, and happiness of a vegetarian tropical people, would freely throw the cultivation and manufacture of it open to private enterprise, and raise as large a revenue from its export from India as it would bear. The whole public revenue of India might, in this way, be derived from its export, and the people of India left practically untaxed. But who are we, that we should object to the people of India and China using opium as a narcotic stimulant. You have all read in the *Times* of the 17th ult., the statement of the yearly drink bill of the United Kingdom, prepared by the Rev. Dr. Dawson Burns. It mounts up to £141,000,000, or £3 15s. per head of our highly Christian population. Sir John Hart, the Inspector-General of Chinese Customs has, in an elaborate memorandum, estimated the total sum spent on opium by "the heathen Chinee" to be, at the outside, £25,000,000; or an average of twenty pence per head. If we replaced our Christian drink by the Chinese heathen opium, our annual expenditure on the same would be but £3,150,000, instead of £141,000,000, a great saving to the pockets of British consumers; while if the Chinese could only be induced by our missionaries to give up their opium, and take—for it would come to this at last—our drink instead, their annual drink bill would be £1,125,000,000, a prodigious prospective profit to the British and other manufacturers of every denomination of strong drinks. And were the Imperial Government to force the Government of India to abolish the production and habitual use of opium in that country, an unlooked for market, of immeasurable magnitude,

* While Mr. Alexander—whose fairness in controversy, and unfailing courtesy on all occasions, I desire to warmly acknowledge—was speaking, the following extract was handed up for me to read from Sir Charles Bernard's well-known "Note," appended to Sir Charles Aitchison's Report on the "Use of Opium in Burmah":—"Neither in the gaols, nor in the opium shops, nor in the villages, save in Minlyin, did I come across actual tangible evidence of the effects of opium." To this a reply was vociferously made from the back benches that, when Sir Charles wrote the "Note," he had been only two months in Burmah. But I have since ascertained from Sir Charles Bernard that he still stands by his "Note," and to every word of the above extract.—Geo. B.

would be opened to our gin and whiskey distillers there also. Few things indeed could be more perilous than that a question so vast and intricate in its nature, and so far-reaching in its bearings, should be hurried on to the arbitrament, as is proposed, of the British constituencies at the next General Election. It is in this impatient, reckless, and suicidal manner, that not only economic, social, administrative, and political, but even literary, scientific, artistic, and religious questions are now treated in this country, until every problem of our national life is being confused by irresponsible counsels, and turned to our destruction; and from a present so oppressed by popular prejudices and passions the outlook into the future would indeed be full of humiliation and bitterness and despair, but for the support derived from the historical conviction that this world is overruled by a predetermining power which, whether the necessity of nature or the supernatural will of universal belief, directs the destinies of nations through every deviation into error and evil, to the enduring ends of truth and righteousness.

The Rev. F. Storrs - Turner:—I expected to hear a discussion of the actual position of the opium question — a discussion starting from Lord Lansdowne's reply to the anti-opium memorial—but the debate has reverted to ancient history. The anti-opium party have no fear of an appeal to history. The verdict of history has been written, the verdict of the national conscience has been pronounced, in a final and irreversible condemnation of our wicked Chinese wars. With all respect to such distinguished men as Sir Thomas Wade and Mr. Lay, who were no mean actors in that history, I venture to tell them, with the utmost confidence, that nothing which they can say will avail to alter one tittle of that verdict. Nay, more, I am bold to say to their faces, that if they could now say anything which could avail to reverse, or seriously to mitigate, that verdict, they would thereby prove themselves gravely culpable in having kept silence so long. They are not blame-worthy, because they have nothing new to tell. In this whole, sad story, from the smuggling of opium in the beginning of this century to the Chefoo Convention, there are no secrets, no inexplicable passages. It is interesting to listen to men who have helped to make history, and their personal reminiscences may correct small details, but neither of these gentlemen has told us anything of substantial importance which was not known before, partly through their own reports, partly in other ways. Mr. Lay has told us something of the arrogance, insolence, and stupidity of the Canton mandarins. But that is not news. I have said on scores of platforms that opium was not the only cause of the first war. I can show to Mr. Lay in my book, "British Opium Policy," printed in 1876, passages setting forth that side of the case, which I think he would acknowledge, do not fall short of what he has said to-day. But did Chinese pride and impracticability justify the East India Company, the British Parliament, and British merchants for their complicity in smuggling poison into China? There might have been a war if there had been no such thing as opium in existence. The war that actually took place from 1839 to 1842 began from the opium trade, and ended with extorting from the Chinese the price of the smuggled opium which they had destroyed, leaving the smuggling to go on just as before! In this brief space it is impossible to give even the slightest sketch of the history. Mr. Lay has left out almost all the important facts; he said not a word of the repeated warnings to the merchants, of their defiance of the Chinese Government and of their own superintendent, Captain Elliott, of scenes of bloodshed and violence which make one wonder that the scandalous story of wicked lawlessness did not end in a wholesale massacre of the merchants engaged in the nefarious traffic, and of the rest of the foreigners who were with them. Lin took the opium and spared their lives. You have heard from Mr. Lay, that Captain Elliott kissed the rod, and begged to be allowed to resume trade. Mr. Lay numbered Lin's refusal among his reasons to justify the war. But he did not tell you that what the Chinese wanted was a guarantee that the merchants would henceforth nevermore smuggle opium. This Elliott could not give. Why, the merchants began to smuggle again the very instant they got a fresh supply of the drug! They were resolved to continue the illegal traffic. The East India Company was continuing to prepare the drug for the smugglers. The British Government had persistently declined to interfere. Yet Mr. Lay makes it an accusation against Commissioner Lin, who had been sent from Peking with express orders to extirpate the smuggling trade, that he did not permit these opium-smugglers to have comfortable head-quarters in Canton or Macao! To Sir Thomas Wade—for whom I feel sincere respect, and, if he will permit me to say so, even affection, on account of his zealous and benevolent exertions on behalf of the Chinese famine fund, for which we pleaded side by side—I have no space to reply satisfactorily. I have ventured to remind him that in 1842, Sir Henry Pottinger, under instructions, endeavoured to induce the Chinese Government to legalise the opium trade and was repulsed. Humbled and vanquished by our arms, the Chinese Emperor is reported to have made this memorable answer:—"It is true I cannot prevent the introduction of the flowing poison; gainseeking and corrupt men will not profit and sensuality defeat my wishes; but nothing will induce me to derive a revenue from the vice and misery of my people." Sir Henry Pottinger, an honourable and humane man, as is evident from his proclamations, would, after this refusal, have put a stop to the opium smuggling if he could, but his superiors would not allow him a free hand. I entirely believe Sir Thomas Wade and Mr. Lay when they say that neither they nor Lord Elgin used menace or

force to extort the legalisation of opium; but as to the fact, the legalisation was a result of the "Arrow" war, and as to whether the Chinese felt themselves compelled or not, I would go to the Chinese for information. Prince Kung's subsequent despatch in 1869 is an expression of the Chinese feeling, which puts the matter beyond controversy. There never was an agreement negotiated on equal terms, freely and voluntarily, on both sides, between Great Britain and China, previously to the Additional Article to the Chefoo Convention, signed in London in 1885. If the evangelisation of China is the best hope for the deliverance of that mighty people from the thraldom of opium, so also the best and surest means to convert the Chinese to Christianity would be the summary and entire suppression of all opium exportation from India to China. Such an act of righteousness, of pity, of atonement, would be a stronger auxiliary to our missions than the addition of ten thousand missionaries, even though they were able to take the Han-lin degree in Peking.

Sir JOSEPH FAYRER, K.C.S.I., M.D., F.R.S.:—I regret that I was obliged to leave the meeting at such an early stage of the discussion, another engagement rendering it impossible for me to remain. I was much interested and instructed by Mr. Batten's paper upon the opium question, which was most elaborately and, as I thought, fairly stated, with, perhaps, a tendency to under estimate such evils as arise out of the abuse of opium. With the historical, political, geographical, commercial, and statistical portions of the paper my remarks are not concerned; they will refer to the important question regarding the use of opium and its influence upon the health of the population of India and China, or wherever else it may be resorted to as a habit. It is most strenuously urged by a large and influential, and, as I believe, thoroughly conscientious party, that the use of opium, either by eating or smoking, is attended with the most pernicious results, causing, sooner or later, demoralisation and destruction alike of body and mind. They seem to be of opinion that the degraded condition of the *habitués* of opium-eating or smoking houses, whether in India or China, represents the natural and, one might almost say, the inevitable results of the use of opium. Ideally, one would wish that stimulants and narcotics, such as alcohol, hemp, opium, tobacco, chloral, and sundry others of recent invention, had no existence; but, unfortunately, human nature is so constituted that it will not forego the use of these drugs, each and all of which is liable to be abused, and when so abused, produces the most degrading and pernicious effects upon the human race. One of the curses of our own country and our own race is the abuse of alcohol—the amount of disease, misery, and crime produced by it is incalculable. With any who might enter upon a crusade against this form of indulgence, which should correct the abuse and limit the use of it within reasonable bounds, I confess that I should have the greatest sympathy; but I should never expect to succeed in excluding alcohol altogether from use as food. There cannot be a doubt that, in the great cities of India, in China, and probably elsewhere in the East, the abuse of opium is carried by a certain, but a limited number, to a great extent, but to nothing like the extent to which the abuse of alcohol is carried. It is well known that, over large areas of country in India, by tens of thousands of people, opium, in moderation, is habitually used by the natives; and that they have a thorough belief in its efficiency to protect them against malarious disease; and that, under its influence, all the functions of life are better performed; that life is not shortened; and that physical and mental conditions are improved and not deteriorated. This I know to receive the support of those who know far more about the subject than I do, and I am not aware of anything to controvert it. It is said, I believe, by its opponents, that the tendency of opium-eating is ever to increase—to induce, it may be, slow, but sure degradation and destruction. I do not believe this. In the course of many years' experience in India, I have known so many who have been habitual consumers of a small quantity of opium, without in any way suffering from it, or without any tendency to increase the habit, that I am unable to agree with those who state otherwise. One of my most intimate friends—a native nobleman, with whom I frequently associated—died after the age of eighty. He was a man of remarkable intellectual, mental, and physical vigour, of wonderful powers of endurance of fatigue, a great sportsman, a spendid shot, as complete an example of a native gentleman as one could wish to see. He was an opium-eater, and consumed his two or three doses a day with unerring regularity. This he had done for many years when I became acquainted with him. He never increased the quantity, nor had he done so for several years; he showed no signs of degeneration, mental or physical, or anything suggestive of a pernicious habit. It must be in the experience of old residents in India to have met with similar cases. It seems to me that this crusade against opium, though well meant, is not reasonable. It is as unfair to argue from the *habitués* of opium-smoking houses, as it is from the frequenters of gin palaces and other haunts where the most degraded forms of alcoholic abuse may be met with in our own country. Both, in extreme cases, are an evil; but the moderate use either of alcohol or opium must be left to the discretion of those who feel called upon to take them. There is another drug which is also in frequent use in India, the hemp (*cannabis*), which is infinitely worse than opium. I find no objection taken to this drug by the anti-opium party. I can see no medical ground that would justify violent interference with the custom in question. Control and limit the abuse of opium, but to interfere with and suppress it altogether seems to me unjustifiable.

I know no reason why opium should be interfered with and alcohol be exempt. The evils of the one are far inferior to the evils of the other, and the moderate use of both—as I have said—should be left to the discretion of those who want them. It seems to me to be clearly proved that the moderate use of opium is not attended with the evil results ascribed to it, though, as with alcohol, a certain number of persons will abuse it. I repeat, therefore, that on medical grounds I see no reasons for advocating the abrogation of the present regulations concerning opium in India. I confine myself entirely to the medical aspect. Other and convincing reasons for maintaining them have been ably advocated in the exhaustive paper to which I am now referring.

Mr. MAURICE GREGORY (Editor, *Banner of Asia*, Bombay):—Mr. Batten has stated that the gross profits of the Bengal poppy cultivators are Rs. 5 per seer of opium. Out of this the heavy Government advances have to be repaid. Sir Charles Aitcheson shows on page 40 of Blue-book just issued on "Opium" (C.—6562 of 1892), that the nett profit of the cultivators at the time of writing was 4 as. 8 pies per seer of opium produced. For each seer the Government obtained Rs. 48 8 as. In other words the Government allows the cultivators 1½d. out of every £ of its own profits. In like manner, on every chest of opium exported from Malwa, the Government levies Rs. 600, which only permits the rajahs to levy an average duty of Rs. 10. In other words the rajahs obtain 2½d. for every £ levied by the Imperial Government. The fact should be emphasised that the opium prepared by the British Government in India is almost entirely used for purposes of debauch. John Dudgeon, M.D., Surgeon to the Peking Hospital, late Honorary Physician to her Majesty's Ambassador at Pekin, Professor of Anatomy in the Tieng Weng Kwan, speaking of the sexual effects of the drug, as prepared for smoking by the Indian Government, says:—"Its moderate use causes, for a time, a feeling of renewed vigour, and perfect present enjoyment; and this is one of the chief reasons assigned for the commencement of, and addition to the habit. Ultimately, the reverse condition ensues, and the poor smoker is practically impotent" (page 576 "Transactions Social Science Association," Liverpool Meeting, 1876). Similar evidence is given by Dr. Osgood, of the Foochow Medical Missionary Hospital (experience of 1,100 cases of opium-smokers); Dr. James Watson, of Newchang, in "Medical Reports," published by order of the Inspector-General of Customs; J. Kenneth Mackenzie, L.R.C.P., M.R.C.S., late of the Hankow Hospital, and of Tientsin, where a hospital was built for him by the great Chinese statesman, Li Hung Chang; George Shearer, M.D., F.L.S.; James Galt, F.R.C.S. and L.R.C.P., Edin., seven years in charge of the Opium Refuge, Hangchow; and many others. Dr. A. G. Reid, of the Chinese Imperial Customs Service, of Hankow, speaking of the worse than bestial degradation of the opium smoker, says that he will even sell his wife in order to obtain the drug. Dr. Ayres, colonial surgeon, of Hong Kong, says that "opium-eating is a terrible vice most difficult to cure, and showing rapidly very marked constitutional effects in the consumer." That these constitutional effects are the same as in opium-smoking is proved from the evidence of William Huntley, M.B., C.M., of Nusserabad, Rajputana, who has made exhaustive investigations into this matter. Writing in the "United Presbyterian Magazine" for December, 1890, Dr. Huntley says:—"For those between the ages of 20 and 40 there is an inducement to opium-eating which need here only be mentioned in order that men may honestly know the character of the drug we are dealing with. The temptation for the great majority of those who are in the prime of manhood is expressed in one word—*lust*. Comment is unnecessary." The leaders of the anti-opium party in England wished to be spared the necessity of bringing this awful aspect of the opium question before the British public; but they will be forced to do so if the supporters of the opium traffic continue their present tactics.

Surgeon-General Sir WILLIAM MOORE, K.C.I.E.:—It appears to me, that the vital point on which all others hinge is the question whether opium is or is not the very injurious agent which it has been asserted to be. For the last twenty-five years I have studied this question among habitual opium consumers, and on the principle of experimenting on the vile body I have used opium myself. I confidently assert that opium is not the deadly agent which it has been painted; and that climate, creed, habits, and customs, renders it almost a necessity for Eastern races. No one denies that the active principles of opium are poisonous, but so are the alkaloids of other things in daily use—tea and coffee, for instance. And so is alcohol, if taken in excess. But the vast majority of opium users do not exceed, any more than the great majority of ourselves taking fermented drinks. I have also to assert that no organic disease is caused by opium, while alcohol, as is well known, causes many organic affections, and in the most important organs of the body. Only two or three days back, Lord Herschell asked for a Parliamentary Committee to inquire into the best mode of dealing with habitual drunkards. It would I think, be better if the anti-opiumists combated drunkenness here, instead of the use of opium abroad, amongst people who, as he remarked before, are impelled to the use of opium by climate, creed, and long custom. And it would certainly be more in accordance with rectitude if the anti-opiumists refrained from sensational, exaggerated, and often untruthful statements, such as for example, that opium is destroying the Chinese nation; that the use of opium accounts for pauperism among the

Chinese; that smoking opium is more deleterious than eating it; that the maladies met with in opium shops are the result of opium; that opium prevents missionary success; that every one using opium goes from bad to worse; that the cultivation of opium in India takes up so much ground there is not enough left for cereals, and so famines occur; that if the Indian supply ceased, opium consumption would be stopped in China; that Indian cultivators are forced to grow opium; that Indian princes on whose territory opium is grown would gladly abandon the revenue derived from this source; that no benefit can possibly be derived from the use of opium. With reference to these and many other errors of anti-opiumists, I say there is scarcely an atom of truth as a foundation. If the anti-opiumists succeeded in their endeavours to abolish the use of opium in India, excepting when prescribed by a physician, the last state of thousands of poor people in India would be worse than the first. The person suffering from want of food would not be able to appease the hungry edge of appetite by the customary dose of opium, and when scarcity or famine occur, thousands more would die than before. The person having to undergo great physical fatigue would not be able to render himself proof against it by opium, neither would he be able to share the opium with his camel or horse, which, especially before the days of railways, was a point of honour with the riders. The Rajput would not be able to offer the stirrup-cup of opium water, of which I have often partaken, to his friend, as the latter leaves before the grey of the morning, or with the rising of the moon in the evening, for a 30-mile ride over the sands of Maiwar, Têysulmeer, or Bickaneer. The opium-pipe could not be introduced as now, when, after the evening meal, it takes the place of the wine or spirits consumed in other countries. But, perhaps, the worst results would fall on the *habitués* of the opium shops. At least half the people who frequent the opium shops are suffering from some malady. Those who cast stones with such virulence and so promiscuously at these poor opium smokers, do so in ignorance, and without the grace of that test of virtue's charity. They ignorantly regard the maladies which they see in opium shops, not as diseases for the relief of which opium is taken, but as the effects of opium. Lastly, opium is frequently used as a safeguard against malarious fevers, which could not be done if a physician's prescription were required, for there is not a competent doctor in every Indian village, as there is in this country. The anti-opiumists have done quite enough to render themselves ridiculous, for they have been endeavouring to achieve an impossibility. The desire for a stimulant has existed during all ages and among all peoples, and there are certain reasons connected with climate, religion, habits, customs, why Easterns use opium. If it were possible to prevent the use of opium in India, the people would take to native liquor, or to the still more injurious preparations of the Indian hemp plant. I am quite certain, after many years close attention to the matter, that stopping the use of opium in India would in many ways do infinite harm to the people of many parts of the country. As Mr. Batten has observed, you may inflict a cruel injury on India, the extent and consequences of which you are incapable of calculating, and you will fail in anyway to benefit China. Because a comparatively few people may injure themselves by excess in opium, is no reason why the majority should be deprived of opium. If means of enjoyment are to be stopped because some people are prone to abuse them, there will soon be no means of enjoyment left to us.

Mr. E. L. OXENHAM (late British Consul in China):—Opium-smoking is, it must be remembered, purely artificial, and is not, as in the case of drinking, the abuse of a natural desire. Everyone must drink something, but no one need smoke anything. I am, however, able to confirm the statements made as to opium being a prophylactic against fever. It is so used among the people dwelling on the low lands bordering on the Yang-tze, and in the malarious island of Formosa, the coolies, who can do their twenty-five miles a day, universally smoke it, and cannot do without it. The high price of quinine makes its sale prohibitive for the poor. Outside the malarious districts the use of opium is wholly an abuse. The rich use it—not indeed, with impunity, for the "craving" for a pipe increases year by year—but with naturally less disastrous effects on the family. But opium, among the poor, works terrible havoc; in eight cases out of ten the bread-winner of the family becomes, after a few years, useless, and the support of the family devolves on the women. The historical aspect of opium trade has been dealt with by gentlemen of highest authority, but what concerns us now is the state of the case in 1892. That is, do the Chinese, who have no sinister interest in the traffic or cultivation of opium, desire the continuation of the trade now? Would a Chinese Parliament vote for such a traffic? No one with any knowledge of China would answer in affirmative. The opium is equally denounced by the Government, by the Confucian *literati*, and by the Buddhist and Taoist priesthood. Proclamations, placards, tracts, and prints issued by members of above bodies abound in every town, and denounce the deluge of "foreign mud poison" which is being poured into the empire. Do foreigners themselves like or employ opium-smokers? Do they ever knowingly engage a teacher or servant who smokes opium, and are not such *employés* invariably found inefficient? Much is made of the fact that the Chinese officials do not take effectual measures to suppress the trade and the cultivation. In the first place, both have attained such huge proportions that nothing but measures, tyrannical and bloody in a high degree, would be able to suppress even half of the existing trade; and in the second place, is it possible in a democratic

country like China for the Government officials deliberately to deprive their own countrymen of profits on an article, when profits on the same traffic are deliberately granted by treaty to foreigners. It seems to me, as regards opium, that China should be allowed to "gang its own gait," without any foreign interference, as is the case in Japan. By this means China's sense of wrong and oppression is appeased, while the love of compromise inherent in the Chinese mind may be trusted not to act injudiciously. Railways are probably the direction where lies the true salvation of China. By their aid their existing and admirable educational framework will be strengthened, revived, and improved, and the reform of the individual, insisted on by Confucius as the only real and stable foundation of national welfare, may be more nearly attained.

Surgeon Lieutenant - Colonel HENDLEY: — I understand that 5,000 medical men have signed a memorial, in which it is contended, amongst other things, that the use of opium is morally and physically debasing, and associated with many great dangers to the people of India. I have practised in the native States of Rajputana since 1871, and for more than ten years have been responsible for the medical arrangements for nearly 3,000,000 people. More than 1,000,000 new cases have been treated during that period in the dispensaries under my supervision, and I have myself seen from 100 to 200 cases of sickness every day. As the result of my experience, and in opposition to previous personal, but ignorant, prejudice, I am bound to state (1) that I have not seen life shortened by the habitual use of opium as a stimulant, but, on the contrary, I have come to the conclusion that the habitual opium eater becomes happily oblivious of most of the minor ills of life, such as bad food, irregular meals, poor clothing, and exposure to wet and cold, and that he is hardened, as it were, against many diseases, as for example, rheumatism, or those of malarious origin. (2) That it is only by the use of opium that mounted police, and messengers, or guards in Native States can perform the long journeys which are required from them for many years—in short, that without this, or some other stimulant, they would soon be useless, and life to them be not worth living. (3) That I do not recollect the occurrence of any fatal cases arising from the use of opium as an habitual stimulant. No one can deny that opium can be, and is occasionally, abused like many other good gifts, but my experience has convinced me that the evils attending the use of this drug are infinitesimal in comparison with those which, in so many cases, go with drinking spirit, wine, and the use of tobacco and even teas. Of course I have seen many cases in which opium has been taken as a poison, or in overdose by unexperienced persons. When I first went to Rajputana, I was horrified at the large quantities of opium taken by some Rajputs, and predicted fatal results, but as no such cases occurred, I have naturally changed my views. We are told that opium debases and destroys those who use it. Occasionally one sees a man who is a slave to the habit and somewhat useless in consequence, but on the other hand one of the most able natives I ever saw, took daily a dose of opium as large as a billiard-ball. As not uninteresting in connection with the prophylactic uses of opium, I may refer to Mr. Strez's observations many years ago, that a large dose of opium will protect againist the ill-results of exposure to wet and cold. For example, a drachm of laudanum taken by a traveller on the outside of a coach in a storm would enable him to journey without fear of being chilled, or of getting pneumonia even if he became wet through. It has been stated that opium cannot be given up without fearful agony. I have frequently stopped its use at once, without ill results, and with far less fear of evil then when ordering alcohol to be given up. I would not hesitate for a moment to substitute the opium for the spirit-drinking habit, on the grounds that the latter is destructive to body and soul, shortens life, leads to far more family misery, and to terrible crimes, and is much more likely to lead others astray by imitation. In short, the drunkard is a nuisance and danger to himself and all around him; while the opium-eater, only in rare cases—at all events, in India—hurts himself alone, or only indirectly, by spending perhaps an unfair share of his earnings, injures his family. In China, he is said sometimes to sell his wife; but surely this is the fault of the law. An English drunkard beats her, which is as bad, and would sell her if he could; indeed, I believe he has done as much in some mining districts. It is highly probable that any injury done to families, by heavy expenditure in opium, has been compensated to them by its prophylactic value, which has preserved valuable lives. Opium does not fill Indian lunatic asylums; Indian hemp and alcohol do this. If opium were increasingly injurious, the population would have diminished, instead of multiplying enormously. My remarks relate to opium-eating; but there is evidence to show that opium-smoking is less dangerous, as, in the latter case, the alkaloids are not absorbed. A very distinguished authority on drugs has referred me to a paper in the "Journal of the Chemical Society" for 1871, by Vohl and Eulenberg, on the "Physiological Action of Tobacco," in which it is stated that the action of that drug, when used as a narcotic, is due to pyridine and picoline bases, and that there is no nicotine in tobacco smoke; so of opium when smoked, the action is due not to the alkaloids but to the bases which it contains. The memorial goes on to say that the cultivation of the poppy may be prohibited in British territory and in the native States, and that opium may be sold by druggists under the strict regulations now in force in England. What are these regulations? Strict regulations exist it is true, yet as "Hygiene" shows they are openly violated under the Government patent stamp. To use a favourite anti-

opiumist argument, every ounce of chlorodyne contains 12 doses of morphia, 36 doses of chloroform, some Indian hemp, and sometimes 6 doses of prussic acid. Yet one young woman actually bought from a West-end druggist, in one fortnight, 42 ounces of chlorodyne, and a man regularly took a bottle a day. Only last Monday a jury strongly condemned the sale of a large quantity of opium which had been supplied to a clergyman who afterwards committed suicide. Another druggist told me that private persons constantly bought and consumed dangerous quantities of antipyrine. The soothing syrups and powders which are given so freely to children contain opium in unknown quantities. Surely it is better to give the drug undisguised as Indian mothers do. Are restrictions such as I have indicated those to be enforced in India? The native of India uses many stimulants. The respectable man most frequently takes opium because with Mohamedans and some Hindus wine is unlawful. The lower classes drink spirit and use many drugs, the worst of which are the preparations of Indian hemp. I see many broken-down Sepoys, all of whom take a stimulant to drown care and hardship, but they live on, unshortened lives. I think, perhaps, that *pâu* amongst the rich is responsible for as much diseaes and trouble as opium. Now as regards native States, the prohibition of the growth of the poppy would involve gross breach of treaty, or the re-establishment of the Customs lines with all its difficulties, that is to say, if we only taxed the opium manufactured in those States, for I do not think it would be possible to prevent its export, certainly not from ports in native States. To attempt to stop the cultivation of the poppy in India, or to prevent the use of the drug altogether, seems to me somewhat as though we should try to force a British colony to give up the use of, and cease to grow tobacco, which if used to excess, some of us believe to be as harmful, and certainly more offensive than opium. As we do not dare to do this, is it not cowardly to treat India on the opium question in a way that we are excluded from doing towards other parts of the Empire. The excessive use of alcohol, opium, tea, or any stimulant certainly demands all opposition we can give, and I think that if anti-opiumists would teach moderation in all things, they would do good; and perhaps, I might add, that they can hardly expect to succeed in this, or any other question, unless they cease to abuse officials, who, after all, are as likely to be actuated by good motives as themselves. Some of the remarks made at page 12 of a pamphlet, entitled "The Poppy Plague in India," are such as would disgrace the most abandoned opium-eater. The map attached to the same publication, and the remarks as to dose which follow, are most misleading, and the deductions as to poisoning the population untrue. The Anti-Opium Committee have also published a letter which was sent to over 40,000 ministers. I think it was rather insulting to the education and intelligence of these ministers to state that the Chinese belonged to the "race by whose hands God wrote his Holy Book; the race that produced the great characters of sacred history, the patriarchs, the prophets, and the first martyrs of the Cross," yet this is what the letter does state.

Dr. J. L. Maxwell:—The reader of the paper has emphasised two points—one, the blamelessness, first and last, of our opium relations with China; the other, the comparative harmlessness of the drug. I want to say a word or two on each of these points. With regard to the first, I should like the following questions answered:—(1.) Is it or is it not true that, on the occasion of the first large venture in opium to China by Warren Hastings, the then Governor-General, the supercargoes at Canton wrote to Calcutta:—"The importation of opium being strongly prohibited by the Chinese Government, and a business altogether new to us, it was necessary to take our measures with the utmost caution?" (2.) Is it the case or not that the Court of Directors sharply rebuked the Governor-General in following terms:—"Under any circumstances it is beneath the Company to be engaged in such a clandestine trade; we therefore hereby positively prohibit any more opium being sent to China on the Company's account?" If I am right in asserting that both of these questions must be answered in the affirmative, is it not our part as honest men to acknowledge that our opium trade with China in the form which it then assumed, and in which it was continued, was distinctly an unrighteous trade? Passing to the first opium war, I should like to ask whether, for at least four months before Commissioner Lin's *coup de main*, the Chinese Government had been able so effectually to block the trade that it was in a state of thorough stagnation, and whether, having succeeded so far, it would uot have been sheer folly on Lin's part to allow of the standing menace of a large opium fleet in Chinese waters? I put this question, not because I do not fully admit Sir Thomas Wade's hearty condemnation of the haughty and contemptuous behaviour of the Chinese authorities to Lord Napier and his successors, but to make perfectly plain that the Chinese Government were in earnest, that our Commissioner and the merchants had received long warning, and that it is impossible for us to put ourselves into the position of the Chinese, and not feel that we ourselves would have acted as Lin did. Are we not justified in saying that the first opium war, whatever the faults of some of Lin's methods, was a cruel injustice? I shall not attempt to discuss the methods by which Lord Clarendon's instructions to Lord Elgin, in 1858, about the legalisation of the opium trade were carried out. I accept the statements of the Secretaries that the legalising proposals came from the Chinese side, and I accept also the testimony of our Plenipotentiary that all we then gained was extorted from the fear of the Chinese, that

is to say, that the proposals of the Chinese were the natural outcome of their submission to the adverse decision of arms. But what I should like to know with regard to the entire righteousness of our action in that matter is this (1) who suggested the provision of the Tien-tsn Treaty, that in the revision of the tariff once in ten years, there should be no revision of the opium tariff? (2) If we were so exceedingly careful and innocent as to opium legalisation, why so dreadfully hardhearted to China's appeal through Sir Rutherford Alcock in 1869? (3) If China and China only had declined the opium portion of the Tien-tsn Treaty, what possible explanation can there be of the many years delay in ratifying the Chinese *quid pro quo* of the Chefoo Convention? and (4) if we are the never-failingly righteous and innocent people in our Chinese relations, which Mr. Batten claims to be our character, what possible meaning has the clause in the Chefoo Convention, which forbids China to think of raising the tax on Indian opium till she has taxed her home-grown opium to the same extent? Some of us are sick of hearing that China is free. With such a clause as that how can she be free? Let us try on such a policy with the United States or with France before we talk of China's freedom. We dare to ask the entire repudiaton of that clause. It is a scandal on our name. With regard to the second point, I desire earnestly to deny the comparative harmlessness of the drug, and to assert that it is of such a character that it should not be regarded as a legal or proper article of commerce except for medical purposes. There is, in the action of the Indian Government itself, a *primâ facie* evidence that it recognises its hurtful and demoralising power. It has steadily and wisely refused to permit free cultivation, and it has done so, on its own showing, because it would lead to great demoralisation. We have the highest Indian authority for believing that when opium was freely grown in Assam, it led to such a condition of things as affected not only the land revenue, and that very seriously, but as threatened the continued existence of the people. The Indian Government put down, with a strong hand, the free cultivation in Assam, and it did right. It is therefore idle, and worse than idle, to talk lightly of the pernicious effects of opium. A whole century of limited areas of cultivation, and of boasts again and again repeated, that these limited areas aimed at the preservation of the people and to prevent the spread of the opium habit in India, shows unmistakably that the Indian Government recognises that there is attaching to this drug, and to its use for other than medical purposes, elements of grave danger. The question is not one of danger, but of the measure of restraint in view of that danger. Now, what I assert is that the position of the Indian Government is self-contradictory. On the ground of experience, it puts down free cultivation in Assam because it is destructive, but it does not hesitate, on the one hand, to pour into China what it believes to be associated in its use with grave danger, while, on the other, it deliberately, for the sake of the revenue from China, exposes a vast army of its own people to all the dangers of free cultivation, to the allurements, on the one side, of a fascinating vice, and to the demoralisation, on the other, produced by the ever present temptation to smuggle one of the most easily smuggled drugs, and to add to the scanty receipts from Government the richer proceeds of illicit commerce. The million of acres required for the China trade is a perpetual source of mischief to a million of cultivators, and, through them, to how many more, and is a menace of the gravest character to the whole Indian Empire. But I pass to my final word on this subject of the pernicious influence of the drug. There are three classes of men, whose voices are now raised upon this topic. There is the official class of India; there are the native populations affected by the habit and its dangers; and there is the medical profession, at home and in the East. Mr. Batten says, of the first, that not a single Englishman, who has been responsible for the well-being of India, has ever suggested the prohibition of the cultivation of the poppy. Be it so; but what of the use of the drug? Are the names of Aitchison and Mackenzie, and of their co-administrators in Burma, of so slight a value. Have there not been, in the history of Indian administration, men like Sir George Tucker, who have used words of condemnation of the whole system as emphatic as any that the promoters of the present movement have ever used. What I desire especially to say about the whole class of officials—many of them high in office—and I say it with entire respect to them, and thankfulness for the much we owe to them in the administration of a vast Empire—is this, that, on a question affecting the physical and moral well-being of opium *habitués*, it is impossible for them to judge, with the accuracy which is to be expected, either from the natives themselves, or from the medical men who have to deal with them. What do the natives of India say? The Burmese population has spoken in unmistakable terms of utter condemnation. What do the Chinese say? It suits some to decry such evidence; but there is no mistaking the fact that, since Englishmen have come into close contact with the Chinese, the universal testimony, even of the smokers themselves, has been that the habit is, physically and morally, degrading. What do the Rajput opium-eaters say—those wonderful men, who are the stalwart men of India? There is only one carefully and deliberately made series of examinations on the subject, that of a hundred cases of opium eaters at Nusserabad by Dr. W. Huntley. And his testimony is that it was with the utmost difficulty that any single Rajput could be got to acknowledge the habit. Every one was ashamed to confess it. And what do medical men east and west say? First, there is the testimony of 5,300 medical men in this country strongly condemnatory of the trade. Not a few of these have had experience in the East. Second, there is the testimony of the whole medical body,

numbering over 100, which stands in closest relation with the Chinese in all or most of its provinces, and they are one in their condemnation of the habitual use of opium as physically, and morally, and socially a curse. As more than a thousand opium-smokers have passed through my own hands in connection with the habit, I venture to say the same. And third, I hold in my hands a memorial to the House of Commons, signed by over 50 of the qualified medical practitioners of Bombay, earnestly craving the assimilation of the Indian to the English law in respect of opium, and speaking in the strongest terms of the pernicious influences of the habitual use of the drug. Surely all this body of testimony is worthy the careful consideration of those who care not only for the national honour but for the best interests of their fellow-men.

Mr. M. M. Bhownaggree:—The subject of Mr. Batten's excellent paper has been so exhaustively discussed by this meeting, by men whose opinions are entitled to the greatest weight, that I do not feel justified in doing more than briefly touching on that part of it which might be termed its Indian aspect. Even in reference to that part of the subject, such main points as the effect of opium cultivation on the revenues of India, and of its consumption on the opium-eating communities there, have been so fully treated by persons who have for years studied those matters, that I do not feel called upon to say any more than that I fully concur in the views set forth in the paper. I have lived all my life in Bombay, and have intimate acquaintance with parts of Gujarat, especially the Province of Kattyawar, those tracts in Western India where opium is chiefly consumed, and I am prepared to avow that I have never known opium-eating to have spread to any considerable extent, nor the evil arising from that habit to have attained any marked proportions. If legislative interference with regard to one kind of intoxicants more than another is at all required for India, it is with respect to European wines and spirits. While opium-eating might be said to be confined to a mere handful of men here and there, in India the consumption of wines and spirits of European manufacture is gaining ground with such rapidity even among those larger communities which are prohibited by their religion from the use of alcohol, that it is become a crying evil; so that if the anti-opiumites and philanthropic missionaries who are pursuing the shadow of the opium ghost would divert their attention to the importation of spirituous liquors from Europe, they might do some real good in the long run. But perhaps the powerful interest which protects the breweries and distilleries of this and neighbouring countries offers them no inducement in that direction. On the other hand, the further impoverishment of the revenues of India, a considerable portion of which is now raised by a duty levied on the salt which the very poorest of the poor have to eat as a necessary of life, seems to be too trivial a matter for the consideration of these philanthropic friends of India! That India does not need or desire any interference in regard to the growth and consumption of opium, is amply proved by the fact that there has never been any agitation there on the subject. I am aware there have been recently a few meetings held, and some desultory memorials addressed, in the spirit of the agitation raised here, but they are too transparently the work of the agents of this agitation itself to merit any serious consideration as being the voice of India. I crave permission to refute one staple argument incessantly urged by the other side, viz., that the British Government is enforcing the cultivation of opium on large tracts of land in India, and, by implication, the consumption of that drug on the people. This, I need scarcely say, is a monstrous misrepresentation. Government has, over a long number of years, been only trying to reduce the number of the opium-growing territories, and I have in my possession a thick volume, containing the authoritative history of the controversy between it and the whole of the States of the large province of Kattyawar, in which the latter have contended for the last thirty odd years, for the right of growing opium. I am sorry to say that that right has not yet been conceded. But the energy with which the Chiefs of that province have pursued this matter, and the argument they employ—that the denial of such right is harmful to the interests of their subjects, and a source of irritation among them, is an answer of no small significance to those who are responsible for the misrepresentation. As regards the present agitation, I crave leave to relate a little information I have gathered about it. I went to a meeting held last night at the Fraser-street Mission-hall at Chiswick, where a Mrs. Lynn was announced to deliver a lecture on opium, illustrated by lantern slides. In the course of the lecture, which was ably delivered, but full of gross misrepresentations, of the lime-light slides exhibited, two represented a few Chinamen lying wounded or dead, with a due proportion of blood daubed on their bodies:—these, the fair lecturer explained, were the men "murdered" by the Queen's murderers, who, she further explained, were British soldiers, in that great British crime, the Chinese war. She paused here to exhort her hearers not to let a son of theirs be enrolled in the British Army! Another of the plates represented an opium warehouse in India, and yet another a retail shop; these, the lecturer explained, were her Majesty's poison stores. A hymn was sung later on at the meeting, in which it was said that "the influence of English rule on India had been baneful." At the end of the lecture the chairman drew out from his pocket a printed memorial, stating that he, and he hoped the audience, were satisfied that the opium policy of the British Government needed immediate annihilation, and therefore asked them to empower him to sign the memorial which contained a prayer to that effect, on behalf of what he called the "public meet

ing." I might state here that, in the usual speech introducing the lecturer, the chairman had distinctly stated that he knew nothing about the opium question, and that "he did not want to betray his ignorance" by speaking at length. After the memorial was read, or rather mumbled over, I thought it my duty, as a British subject, knowing something about India, and, as a resident of Chiswick, to ask if I might be allowed to speak before the vote of the audience was taken on the memorial. I told the chairman that the lecture was full of exaggerations and mis-statements; that all the arguments employed were one-sided. The Chairman said the meeting was only for a lecture, and not for discussion, and the paper before it was only a memorial, not a petition; and that therefore no discussion was expected or allowable. I bowed to the decision, only pointing out that, whatever it was—memorial or petition—it was not fair to spring such a paper on the audience, and to pass it without hearing remarks offered on the other side. The chairman, however, hurriedly called for the vote, and declared the memorial "passed unanimously." Thus the voice of the public of Chiswick was added last night to the unanimous voice of all parts of Great Britain, calling upon the responsible ministers of the Crown to stop in India the growth, consumption, and trade of the poison "which," to use the fair lecturer's reiterated phrase, "the Christian Queen of England was manufacturing to kill not only her own subjects with, but those of the heathen Emperor of China."

Mr. J. FERGUSON (Editor *Ceylon Observer*), said:—I appear as one who sympathises to a large extent with the work of those who desire to check the consumption of, and limit, if not suppress, the traffic in opium. But I would deprecate as harmful to that very cause, and as showing a dangerous example to our native fellow-subjects, the circulation of exaggerated, highly-coloured stories based, it may be, on the off-hand statements of natives who do not know what is to be made of their so-called facts, and who certainly do not realise the force of the language sometimes used by them. In Ceylon, so far as we know, there is no cultivation of the poppy for opium, and the importation of the article, so far as the Customs' returns show, has not greatly increased for the last thirty years. But I hold in my hand a pamphlet entitled "The Truth upon a Momentous Subject: an appeal to Christian Electors," which contains on one page a note respecting Ceylon which has astounded me, in what is said to be a native gentleman's testimony respecting the "plague" of opium. He speaks of villages being "decimated," and of many of his own relations being ruined by Government opium. Now, I can only say that this is news to me, although I have been thirty years in Ceylon, and all that time a careful reader of mission reports, and, as far as possible, of native news. I am certain, in fact, that the story is a great exaggeration, and I doubt if the native understood the meaning of "decimated." I think, in a matter of this kind, the philanthropists of England should not treat their fellow-countrymen in the East, the Civil servants of India and Ceylon, as the enemies, but as the friends of the natives, and as men who, with few exceptions, are anxious to do what is best for their welfare. But I wish, more particularly, to mention a fact not at all so widely known as it ought to be among the home public. The craving for opium among the people of India and China, in the first instance, is mainly, if not entirely, caused by the prevalence of malarial fever of a depressing type. This is the case in Southern China, in many parts of India (Lower Assam included), and even in the fen districts of England where opium is used, and the best possible remedy for the fever and the true cure for the craving for opium, is found in one of the greatest blessings ever provided for such people in cheap quinine. This is due first to the enterprise of the Indian Government in employing Mr. Clements Markham to get Cinchona plants from Peru, and afterwards in cultivating gardens for them, and to the energy of Ceylon and Indian planters in growing the valuable tree for its bark so freely that quinine in 20 years has gone down from 16s. to below 1s. per ounce. Now, in 1887, I urged on the Anti-Opium Society to try and do something to make known the value of cheap quinine to the millions of China as a most practical means of checking the demand for opium, by curing fever and removing the craving for the "black smoke poison" or laudanum. There is one word more, let me remind you that Mr. Goschen was quite right when he stated in the House of Commons that if the consumers of tea confine themselves to the superior India and Ceylon products (leaving the often uncleanly prepared or adulterated China teas alone) they will do much to discourage and destroy the trade in Indian opium, for it is with the money that the Chinese get for their tea that they are able to buy this luxury of opium.

Surgeon-General JOHN MURRAY, formerly Inspector-General of Hospitals, Bengal:—I was for some years residency surgeon at Indore, the channel through which all the Malwa opium passes to Bombay, and I occasionally acted as opium agent. I took great interest in investigating the cultivation, preparation, and adulteration of the drug, and its use among the natives. I was informed that it added to the comfort and enjoyment of life, without injuring the health, if proper food was used; but if from misfortune the supply of food fell short, people were in the habit of increasing the quantity of opium to relieve the feeling of want, until they destroyed the power of digestion, obscured their intellect, and became the debased victims of debauchery of the type described by the anti-opiumists. On the whole, two points stand out quite clearly as the result of my experience. First, that the use of opium by those who can afford it was

as general in Rajputana as the use of port wine or whiskey was in this couutry in my younger days. Secondly, that besides its invaluable use in medicine, of which this is hardly the place to speak of at length, it has a real place among the gifts of God for brightening and cheering life in a hot or unhealthy climate. It is, in fact, against the abuse, and not the use of opium, that we have, as friends of the race, to fight.

Brigade Surgeon R. PRINGLE: — The value of opium, from a pro-opium point of view, may be summed up in the following, taken from a long article in the *Times* of the 21st March, written apparently with the object of pointing out the climate and geographical lines on which it was of the utmost importance the discussion on Mr. Batten's paper should be carried on. "There is the clearest medical evidence that the general and moderate use of opium by a deltaic population, such as that of Orissa, is an unconscious safeguard—the result of centuries of practical experience—against the endemic diseases of the delta." If it were possible to prove this statement, then the whole position of the opium question would be entirely changed; but I differ *in toto* from this view of the case, and do so from my own knowledge and experience of these endemic diseases in the very delta selected, in which I served as medical officer from the end of 1854 to 1862, first as Civil Surgeon of Juggernauth or Pooree, and then as Civil Medical Officer of Cuttack. This experience was gathered from the salt lands of the Chilka Lake (the most malarious spot on earth, if judged by the victims), and the delta of the Mahanuddy (or great river), to the jungles of the Orissa hills. I consider this statement regarding the beneficial effects of even moderate habitual indulgence in opium as absolutely unsupported by carefully considered facts, as far as my experience went, and cinchona, or "fever medicine" as it was called, in any of its preparations, and in the smallest quantity, was greedily preferred by the natives to opium; indeed as a febrifuge, or prophylactic from fever, I never once, in thirty years' Indian service, was asked for opium as a "fever medicine," and I studied the subject of malarial fever, as much as any medical officer of my length of service in India. For the supporters of the pro-opium medical policy to be consistent on this point, they must be prepared to explain how the poor Burman, in his deltaic country on the east of the Bay of Bengal, differs from the Ooryiah under precisely similar geographical and climatic conditions on the west, to such an extent, that what is viewed as a necessity for the Ooryiah, is such a perniciously dangerous drug for the Burman, that in the Burman opium license the following occurs:—"Sec. 3. That he (the licensee) shall not sell these articles (opium and poppy heads) to Burmans." Again, if opium is such a necessity to secure that "unconscious safeguard" against malarious influences, I ask how the Commissioner of the Central Provinces (Sir Charles Bernard) could explain his action in taking credit to his administration for having taxed opium higher than elsewhere in India. As well tax quinine as opium, if the latter is such an important febrifuge. In explaining how opium could not, in an sense, be a febrifuge, I would point out that the drug, even according to Dr. Watt, tends to "diminish every secretion, except that of the skin;" and Sir William Moore, K.C.I.E., Surgeon-General, Bombay, who has publicly withdrawn from advocating "opium as a necessity," notwithstanding its "beneficial effects," states that he has come to the conclusion "that the only malady opium, in moderation, tends to foster, is the comparatively minor one of constipation;" and further on, in his "Errors of Anti-Opiumists," page 10, adds: "When used for a long period in large quantities, it produces a depressed and quaint hysterical condition, with tendency to diarrhœa." But this constipation is in a great measure due to defective biliary secretion, than which all who have any practical knowledge of malarial fever know of no state which is more favourable to a febrile attack, and none which tends more to a return of the disease, by laying the foundation for that most fatal complication, malarial dysentery. The Chairman, when Lieut.-Governor of the North-West Provinces and Oudh, as also Surgeon-General Cunningham, M.D., then medical adviser to the Government of India, and for 20 years practically the chief sanitary authority in India, must recollect the appalling epidemics of malarial fever which decimated the upper portion of the Mesopotamia of the Ganges and Jumnah; and surely if opium was then considered such a valuable febrifuge as it seems to be now, how was it that it was never given gratuitously, to secure that "unconscious safeguard" from the fatal malarious influences of a system of inundation mistakenly called irrigation, which I have carefully watched as divisional sanitary officer for twenty years from 1864, and seen this fatal influence steadily march from Saharanpur to Manipuri. The Chairman would recollect this artificially-produced malaria in the almost practical depopulation of Hurdvigunge and of Secundrabad, and his being nearly flooded out of his tent at Somnah, between thse places. Here was an ample field for testing the febrifuge virtues of opium; but instead of this, preparations of cinchona were gratuitously distributed, and a vast system of drainage carried out, at an enormous expense, to correct the errors of a system of unscientific irrigation, which produced a water-logging of the soil, greatly increased by a system of unscientific raised-roads, with deficient water-way across the watershed. I enter into these details because if this febrifuge vertue of opium had any real existence, and the Government had any faith in it, it was their duty to give these poor creatures some of this "unconscious safeguard," as they were suffering from the unscientific errors of their rulers, and were in no way responsible for the awful mortality in their midst. I would also draw attention to the late extension of this pestiferous system of inundation to the Deoband Mesopotamia, and

to the mortuary statistics of this district. In 1879, it would seem as if this artificially produced malarial fever had reached a climax, either in the virulence of its power, or in the debilitated condition of the population, or perhaps in both combined, but the result was appalling, for, out of a united population of 4,000,000 in four districts, nearly 500,000 died in a few months; and the very birth-rate was seriously affected next year. How was the calamity met? By a noble distribution of preparations of cinchona on the part of the Government; and the gratitude of these poor people was such, that I can never forget it; and I feel truly thankful to think I had any share in thus showing the evidence of the deep sympathy of the rulers with the ruled. Indeed, the confidence of these fever-stricken people in cinchona was so unbounded, that opium was never thought of; and this was the more remarkable, because the opium poppy had been cultivated in these districts, and in 1881-82, one of them —Alighar—actually refused the favourable opium advances to reintroduce the poppy cultivation, preferring pecuniary difficulties to the cultivation of a plant which, according to the resolution of a late Governor of Bombay in Council about that time, when protesting, on moral grounds, against its introduction into the Presidency, stated he did it on account of the "widespread corruption and demoralisation" it produced when tried in Goojerat. Comment on this is needless. The only beneficial properties connected with opium in malarial fever were anodyne and narcotic, the former in the painful rheumatic symptoms after sunset in malarious districts, and the latter in the restlessness and pain often met with in malarial dysentery; but as a prophylactic I am quite at a loss to understand how this could be advanced. The opium habit, resulting from the benefit received from the anodyne and narcotic virtues of opium as a medicine in fever, independent of its action in combination with other drugs on the skin, is, alas! too often the result of this medicinal exhibition of the drug, and is indulged in after the distressing symptoms for which the opium was first prescribed have passed away, and thus, in not a few localities in Britain opium is largely consumed now, though the malaria has disappeared before the drainage and high cultivation. Were the 5,200 medical men, who signed the declaration against all indulgence in opium, asked, in the case of their own patients suffering from the opium habit, to state the origin of the habit, few, if any, could trace it to aught else than to its having been first prescribed medically, and yet, to secure this unconscious safeguard in malarious districts, the general and moderate use of opium is recommended, without the safeguard of having been medically prescribed, to cease when no longer necessary.

Dr. GEORGE WATT, C.I.E. (Reporter on the Economic Products with the Government of India):—Mr. Batten has been pleased to characterise the chapter on opium which has appeared in my "Dictionary of the Economic Products of India" as a complete monograph on the subject. Perhaps I may be permitted to offer one or two remarks of a personal nature. In writing the article referred to, I was barred from expressing my own peculiar opinions freely, since one of the principles of the Dictionary, enjoined on myself and my collaborateurs, has uniformly been to produce a work that, as far as possible, would be impersonal and impartial. We were free to exhibit the facts available on any subject, whether these were favourable or unfavourable, to what was currently held to be the views of any party in power or the policy of the Government. In drawing up the article "Opium," I venture to think I had before me a larger selection of books, reports, and official correspondence than would be possible for any person not similarly circumstanced. Whatever defects may be found in that article are entirely attributable to me, but to have utilised all the material placed at my disposal would have entailed the publication of several opium volumes, instead of the few pages in one, which alone could be afforded. Even, therefore, had there not been abundant other reasons for the exclusion of my personal opinions on the moral and medical aspects of the opium question, I had at my disposal material of greater interest to the public. But I would desire to avail myself of this opportunity of expressing some of my personal experiences and convictions on this momentous question. Let me, therefore, say that I have now resided in India for over sixteen years, and that during that time I have travelled over the greater part of our Eastern empire, and devoted my energies almost exclusively to an investigation of the resources of that vast country. Naturally, the cultivation of the poppy, and the traffic in opium, has received a considerable share of my attention. On arrival in India, in 1873, I may say that I held very pronounced views opposed to the trade. As a medical man I naturally gave the subject of the habitual use of opium my careful consideration. But to my astonishment I searched in vain amongst the ordinary people of the country for evidence of its injurious effects. It is commonly stated, though I think incorrectly, that the natives of India do not smoke opium. Those who take what may be called larger doses, in most parts of India, eat it or drink preparations that contain it, but I think I am correct when I say that of the 5,000 to 6,000 chests used up in India annually a large portion is smoked, but not in "opium-smoking dens," nor in the special opium pipe. It is mixed with tobacco in very small proportions, and used daily without any injurious efforts whatever, or without any craving being established for an extra pull at the *huble-buble* or the *hukah*. That there are opium dens in the larger towns I am fully aware. I have visited those of Bombay, Calcutta, and Lucknow, but have seen nothing that could be compared with the drinking dens where the poor British sailors are rendered mad with the drink they

are supplied with in India. Indeed, the abuse of alcohol in Europe is a hundred times worse than the excessive consumption of opium in India. Excess in both is undoubtedly injurious, and if the one could be stopped in Europe, it would be right and proper to consider the suppression of the other in India. It would appear, however, to be useless to urge facts and figures to the consideration of theoretical enthusiasts who, having failed to secure repressive legislation in their own country, have now laid themselves open to the charge of seeking a field for their so-called philanthropy in another, the rise or fall of which is to them of less moment than personal notoriety. The question to my mind is, therefore, not one of abuse of opium and alcohol, but of the legitimate use of these luxuries. Can it be said that the consumption of opium, in the small quantities taken in India, is injurious; or, to state the issue in another aspect, is it more injurious than the moderate use of beer, wine, or spirits? To answer this argument is out of the question. I can, therefore, but add my humble opinion to that of the many able speakers who have addressed the meeting, and it is briefly that, though for years I tried to discover any evidence of injury from the moderate use of opium, I failed utterly, and now firmly believe that it is far less injurious than alcohol. But when every person whose opinion is thought worth having has recorded his views, and it is thus ascertained in which way the majority of such personal opinions tend, what have we gained? The verdict of persons not personally interested in a traffic, the total revenue of which was, in 1889-90, Rx. 928,928, or, to be absolutely safe in over rather than understating it, £1,000,000. A population of, say, 258,000,000 are to be deprived of a luxury, which they have been accustomed to for centuries, by a people who pay nearly twenty-five times as much revenue on their corresponding luxury. This is a point, I venture to think, that has not been sufficiently brought out to-night. Any person who may have taken the trouble to read the publications thrust on the public by the anti-opium agitators cannot have failed to observe how carefully the distinction is avoided between purely Indian and Chinese considerations. An illustrated pamphlet, for example, may be procured for one penny at the railway book-stalls, which is said to have been written by two Indian missionaries. We there get pictures of Indians smoking opium, and find scattered here and there, throughout the pages of that disgraceful publication, the facts and figures of the Indian and Chinese trade in such a way that it is difficult for any person not familiar with the actual facts of the case to distinguish the one from the other. The British public are told of "the manner in which Indian statistics on moral subjects are manufactured." They are treated to disjointed quotations from certain Government reports, in which it is stated that "the statistics of licenses are suggestively omitted." The writers of that pamphlet have got hold of the annual administration reports for certain provinces. They have deemed it unnecessary to procure, in connection with this purely technical discussion, the annual Excise reports. Hence the absence from one report, which they chose to consult, of a certain piece of information was by them regarded as proof that Government desired the suppression of that particular item of news. It is too ridiculous to have to allude to such wilful misrepresentations, as I have already trespassed too far. Let me, however, add very briefly that a point made much of by the anti opium missionary authors is capable of a very simple and natural explanation. They have furnished a copy of the form under which licenses are granted in India to sell opium, in which the vendor is required to sell at least a certain amount of Government opium. This fact is characterised as "a device to force the opium poisoning policy by terrorism that would have done credit to Danton, Robespierre, and Marat, the monsters of the French Revolution. It is this unprincipled and loathsome system of finance on the part of a professedly Christian Government, &c., &c." Now, the simple fact is that Government has realised how absolutely helpless it is in repressing the opium traffic. It cannot prohibit poppy culture in the territory of the native princes, indeed it cannot fully stop it in every corner of its own territory. An article that has to pay a prohibitive tax would naturally be a very profitable one could it be brought illicitly to the vendors' shop. It has, therefore, been thought one of the most powerful repressive measures to ascertain the actual consumption in each and every district. This is the course that is pursued by every merchant in the world in ascertaining supply and demand. The Government can control supply; it has to ascertain demand. Having found this out, the vendor is required to pay duty on very nearly the ascertained consumption of the district, so that little or no illicit opium can be sold by him. Any person who wishes to see the effect of Government control and repression of opium, should study the figures of production in relation to revenue. It will there be seen that while the Indian consumption has averaged 4,000 chests or so during the past twenty years, the revenue in opium consumed in India has increased from Rx. 345,918 to Rx. 928,928. Fluctuations in the license to retail, which are fully explained each year in the Excise reports, are of no more importance than that the Indian consumption was 5,605 chests in 1878-79, fell to 591 chests in 1882-83, and was 6,320 chests in 1889-90.

Mr. BATTEN, having seen proofs of the discussion and the other communications, has sent the following reply:—I will briefly refer to some of the remarks made in this discussion by gentlemen whose views are opposed to mine. To Mr. Samuel Smith I would say, that my paper was neither "official" or an "apology," except in the classical sense of a statement of reasons. To label it "an official apology"

does not constitute an answer to the facts and arguments contained in it. Mr. Smith went on to say it was "one-sided." It would be more correct to call it "other-sided." The Anti-Opium Society practically deny that there is more than one side to the question. Opium, they say, is an *unmitigated* evil, except when used purely as a medicine. It produces no benefits to anyone. I have tried to show that there is another side, and that the advantages derived from the use of opium far exceed the evils from its abuse. That there are such evils I do not deny, but they have been grossly exaggerated by the Society for the Suppression of the Opium Trade. If any habitual consumer of the drug is found to be in ill-health, or addicted to vice, it is at once assumed that his disease, or vice, is due to the habit, while the truth frequently is that they previously existed, and that recourse was had to opium to relieve the disease or to minister to the vice. I am quite content to leave to Sir Thomas Wade and Mr. Horatio Lay, than whom there could be no higher authorities, to dispose of the remarks made by Mr. Smith and others on the causes and events of the war with China. Mr. Alexander calmly assumed that the opium trade of India impoverished the people of China, but did not bring forward a single fact to prove this extraordinary contention. The only sense in which the Chinese are impoverished by the trade, is the sense in which Mr. Alexander is impoverished when he pays his grocer's bill. Surely that is no reason for suppressing grocers' shops. I have already dealt with the suggestion that India may, by substituting potatoes for poppies, avoid any loss. The English farmers, who have been driven by low prices to give up growing wheat, have not yet found much consolation in the knowledge that other crops may be grown on the land turned to pasturage. But I would ask, have the Anti-Opium Society ever attempted to estimate the value of the crop they are endeavouring to destroy? For instance, were they, or were they not, aware of the great internal or external trade amounting to not less than £3,000,000 sterling annually in poppy seed? If they did know of it, why have they concealed the fact from those to whom they have been appealing to help them in the destruction of the poppy? If they did not know of it (which I believe to be the case), how do they excuse their ignorance? I do not know which would be the more culpable, ignorance of the facts with which they profess to deal, or suppression of those facts from those whom they profess to enlighten. Mr. Alexander's assertion that Indian opium is of no better quality, but only more intoxicating than Chinese opium, is not borne out by those who have personal knowledge of the matter. Sir Thomas Wade has remarked, in one of his despatches, that when a Chinese gentleman receives a visit from another, he offers his guest a pipe of Indian opium, as a matter of course, just as an English gentleman would offer his guest a Havanna cigar, or a bottle of champagne, rather than a penny Pickwick or ginger wine. Indian opium is acknowledged to have a finer flavour and *cachet* than the China drug. It is certainly purer and freer from deleterious adulterations. To deprive the Chinese of it would be an injury to the richer classes without any benefit to the poorer. Mr. Alexander observed that Mr. Brereton, the solicitor, to whose powerful lectures I referred, had for some years the opium farmer of Hong Kong as one of his clients, and therefore had a pecuniary interest in the trade. Mr. Brereton had retired from his business as a solicitor in China when he delivered his lectures, but in any case, his interest in the maintenance of the trade in opium was surely not so strong as to throw any real discredit on his evidence. How would Mr. Alexander like to be told that nothing he said on the subject of the evils of opium could be believed, because he is secretary to a society whose *raison d'être* is to enlarge on these evils? Mr. Maurice Gregory has got out of his depth when he talks about the Government advances to the cultivators having to be repaid. They are not advances, in the nature of a loan to be repaid in money, but advances on account of the opium, to be adjusted by the delivery of the opium. For instance, a cultivator of two or three acres of poppy may receive from the Government, from time to time, during the progress of the crop, sums of money, amounting to, say, Rs. 50; if he delivers 10 seers of standard opium to the Government officer, the advance is thereby adjusted; if he delivers 40 seers, then Rs. 10 remain recoverable from him, either in cash or in opium. But this liability to repay the amounts advanced to him does not diminish his profit a single cowrie. If Mr. Gregory advances a sovereign to his baker, with the stipulation that he shall take it out in muffins, I fail to see how the baker's profit is diminished by his liability to deliver the muffins to Mr. Gregory. If the cultivator gets little or no profit from the crop, why does he take a license to cultivate it? Mr. Gregory, in his anxiety to charge the Government of India with rapacity and extortionate dealings, both with the cultivator and the Rajahs of Malwa, and thus to minimise the value of the poppy crop to them, omits to see that such a course of conduct is inconsistent with the charge made against the Government of encouraging the growth of the poppy; and that the higher the tax levied by the Government on the opium, the higher will be the price of the opium, and the greater the restrictions on its consumption. Finally, I may say that nothing in this discussion has disproved, or even attempted to disprove the mass of evidence given by persons in the best position to learn the truths—(1) that both in China and India the moderate consumption of opium, even taken daily, is not only harmless but beneficial; (2) that the great majority of the consumers in both countries are moderate consumers; (3) that the abuse or excessive use of opium is injurious, though not to the extent asserted by the Society for the Suppression of the Opium Trade, but the cases are exceptional, and cannot justify the destruction of a trade, the benefits of which far outweigh the evils.

APPLIED ART SECTION.

Tuesday, March 29th, 1892; ALFRED GILBERT, A.R.A., in the chair. The paper read was "The Decorative Uses of Sculpture," by E. ROSCOE MULLINS.

The paper and discussion will be printed in next week's *Journal.*

SIXTEENTH ORDINARY MEETING.

Wednesday, March 30, 1892; J. BIDDULPH MARTIN (Member of the Council), in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, Edgar T., The Cottage, Halstead, Essex.
Archer, Edgar, Ingleside, South Norwood-park, Surrey.
Bean, Alexander Thomas, 7, Victoria-street, S.W.
Curtis, Alfred Harper, 13, South-hill Park-gardens, Hampstead, N.W.
Foster, William, M.A., Chemical Laboratory, Middlesex Hospital, Goodge-street, W.
Gott, B. S., M.A., Corinium, St. Mark's, Cheltenham.
Hills-Johnes, Lieut.-General James, K.C.B., V.C., Dolancothy, Llandilo, South Wales.
Pitt-Rivers, Lieut.-General A., Rushmore, Salisbury.
Staley, Thomas Peace, 2, Fenchurch-avenue, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Corderoy, George, 19, Queen Anne's-gate, S.W.
Cowper, Joseph, Penrith.
Crossley, Arthur W., Bentcliffe-house, Accrington.
Lloyd, Edmund H., Selhurst, 8, The Avenue, Ealing, W.
Ravershaw, Henry Willock, 32, Albany-road, Ealing Dene, W.
Rotch, A. Lawrence, Readville, Massachusetts, U.S.A.
Toop, Robert, Trent-villa, Weston-road, Bournemouth.
Walker, Theodore, Glen-hall, near Leicester.
Wates, Edward A., Lingsugur, Deccan, India.

The paper read was—

FOREIGN EXCHANGE.

BY EWING MATHESON.

If some apology be necessary for bringing forward so old a theme as Foreign Exchange, it may be said that at the present time insufficient knowledge on the subject often hinders the discussion of important questions. Controversies continually arise concerning trade and foreign tariffs, which might be simplified or avoided if there were a wider acquaintance with the instruments by which international commerce is carried on. That is to say, while most business men thoroughly understand the clearing-house system of dealing with inland cheques, by which the balancing of an enormous aggregate of payments involves only an infinitesimal movement of coin or currency, yet the corresponding process of balancing imports and exports by means of foreign bills of exchange is not so generally understood. This unacquaintance largely arises from the circumstance that the gathering together of such bills is in few hands, and the individual trader or manufacturer has seldom occasion or opportunity of seeing the process. Those whose business or profession makes them familiar with the subject, may require a special effort of mind to realise what appears to them a mere rudimentary knowledge is not shared by others, and such well-informed persons will probably find nothing of interest in this paper. None the less, it is a fact that manufacturers and traders do not, as a rule, recognise the principles which govern the foreign commerce of the country. It is true that various books on political economy deal with the subject, but generally in an abstract manner which does not bring the matter home to those who are engaged in particular branches of trade.

The "Theory of the Foreign Exchanges," by the Right Hon. G. J. Goschen, M.P., published in 1863, is still the standard work, although there is need of a new edition brought up to date. The present writer does not presume to touch on the higher branches of the subject as dealt with in the above treatise, or with the more subtle causes of fluctuation in values. It is here merely attempted to give such a summary description of foreign exchange as may assist the ordinary trader in understanding the methods and principles involved.

The historic study of the subject is interesting and fascinating. Barter of goods between foreign countries, even in remote ages, was facilitated by instruments of exchange, as the remittance of gold and silver was troublesome, and did not effect the purpose of the merchant. Among the commercial cases argued before the Athenian Courts were often some relating to the import and export of merchandise; and the eloquence of Demosthenes, as recorded in his private orations, upheld the right of his clients to letters of credit transferring debts in foreign cities. In still more

ancient times, the Chinese transferred indebtedness in distant parts of the empire by portable tablets, suitably impressed. But leaving on one side such ancient histories, the use of foreign bills or letters of credit in Europe was introduced in the 13th century; while, strange to say, inland bills only came into use in Great Britain, and became recognised by law, in the 17th century. In the reign of Edward I., credits on Genoa, Venice, Bruges, Antwerp, Hamburg, and elsewhere, could be purchased in London, with every certainty that they would be honoured on presentation; and a merchant visiting these cities could, if he had no goods of his own to exchange or sell, and without actual money in his possession, provide himself with the means of making purchases. A travelling merchant, so equipped, ran no risk of impoverishment from robbers, the letters of credit he carried being worthless, without some genuine endorsement or authentication. As an able writer has said of the Lombards of that time:—"They invented the letter of change, which immaterialised their wealth, made it portable, imperceptible, defying the confiscation of their persecutors." Or, as Lord Overstone once described bank notes, "they were the shadow of the gold." By gradual growth, the use of bills has vastly extended; they are protected by the laws of all civilised countries; every incident, however trifling, in the commerce of such bills has been strengthened; so that, by a natural evolution, they have attained the position of instruments of barter and exchange.

Let a foreign bill be followed in its track across Europe. A Russian merchant, in Odessa, has shipped wheat to a customer in London, and wants payment. Alone, or under the direction of his banker, he draws a bill on his customer in Mark-lane for the agreed value of his wheat, say £1,000. He draws the bill, say at three months' date; he draws it in favour of the banker (that is, to the banker or his order), and in duplicate, the copy becoming void when the original is paid. The bill, being drawn in Odessa, would be dated according to the old style, and would probably be in French; in English, it would read—

> £1,000. Odessa, 1/13 February, 1892.
> Three months after date pay this First of Exchange (second being unpaid) to the order of Messrs. Kopeckoff, One thousand pounds sterling, value in account.
> PAUL SITOPOLEVITCH.
> To Messrs. John Smith & Co.,
> 500, Mark-lane, London.

Sometimes bills are drawn in triplicate—first, second, and third. The drawing of more than one copy may probably have arisen, for safety and convenience, in days when transmission by post was uncertain. The duplicate, or copy, is now useful in the negotiation of the bill. The banker, whose business it is to buy and sell bills, and who has a personal knowledge of the corn exporter, buys the one in question at a certain rate of exchange, and either pays to the merchant the price in roubles, or makes him an advance till the bill is accepted. He pays for the bill less than the par value in roubles of pounds sterling, because three months' interest has to be allowed for; and he pays slightly less than he would sell at because, like a jobber on the Stock Exchange, he takes as his own profit "the turn of the market." The banker has bought the right to £1,000 in London three months after the bill was created.

Immediately he has bought the corn bill the Russian banker sends to his agents, Messrs. Blank and Co., in London, the original or "first of exchange," with instructions to present it for acceptance. The London corn merchant having been duly advised by the vendor in Odessa of the shipment, and of the drawing of the bill, accepts in ordinary course, and Messrs. Blank and Co. lock up in their safe the accepted bill to await further instructions. The bill, though accepted, is as yet incomplete and useless, for it is not endorsed; the banker in Odessa by this omission retaining his property in the bill. For he also wants to sell it when he can do so at a profit, and on 'Change every day, or in his Counting-house, he waits a purchaser.

A dealer in agricultural implements, who has ordered some thrashing-machines from Lincoln, wants to remit to England, and purchases from the banker as sufficient for his purpose, or as part of a larger sum, the £1,000 bill. The banker endorses to the order of the machine importer and hands to him the copy or "second of exchange," and so gets back his roubles—presumably at a profit. It will be seen that the buyer of the bill has not got a complete document, the bill, though endorsed, bearing no acceptance. But at the foot of the copy is an intimation where the original or "first" is lying in London, and the Lincoln engineer (or his banker for him), presenting the second of exchange as his authority, demands and receives the original with its acceptance. The two—the original and the copy—are pinned together, and so

form one complete document which, on maturity, is presented to the merchant in Mark-lane, or to the bank named in the acceptance, and is paid. It will be seen that although all the parties concerned obtain the money they desire, the Lincoln engineer in sterling, and the Odessa corn exporter in roubles, no money has been remitted either way, nor does either of the parties know of the other's share in the transaction. Although really a barter, the intervention of the bankers hides the nature of it from those immediately concerned. Each has demanded money for his goods, and has received it.

It may be noticed here, in passing, that the reciprocal payments are not made in the same way. While the Odessa merchant generally finds it better to draw on London than to ask for money to be remitted to him, the Lincoln manufacturer prefers, rather than draw a bill on Odessa, that his customer shall remit to London. The foreign importer of British goods also finds this method best, for he can always buy bills payable in London. Obviously, however, this is not a universal rule. When credit is allowed by the English exporter, and especially in the smaller branches of trade, an infinite number of bills are drawn from England upon foreigners to whom goods have been sold. In the English hardware districts, for instance, bills for sums as small as £20 are drawn at dates even up to six months, and such bills, while they go to swell a total which has due weight in the exchanges, are not passed so frequently from hand to hand as are the larger bills of well-known firms.

The example of the Odessa corn bill is, however, a simple transaction comparatively direct, and does not always occur. Indeed, the Lincoln engineer might say of it, "I only wish it were true; my neighbours and I are getting very few orders for machinery from Russia, and yet I see Russian wheat in undiminished quantities coming in." Perhaps it is for Sheffield cutlery, or Nottingham lace, or Bradford merinos, for which the corn bill has been used, and if so the effect on British commerce is the same. But possibly the Russian tariff may be so vindictive against Great Britain, and so wide in its grip, that not nearly enough of these goods are imported to pay for all the wheat that comes, especially when the Russian hemp and tallow have also to be paid for.

If such an uneven case were to occur, and it often does occur between countries, and unless some easy remedy or alternative presented itself, the trade in wheat would be impeded. For the price in roubles at which bills on London could be sold would fall; an entire absence of buyers may even be imagined, and the wheat exporter would have to ask for gold to be remitted to him, the whole cost of which operation—freight, insurance, conveyance to a Russian mint, and commission on its sale—falling on the wheat exporter. For the English buyer would oniy pay the current price of wheat as determined by the supply from all other sources. Such extreme and imaginary cases seldom happen.

When the demand for bills just equals the supply, the exchange stands at par, the money of one country having a value compared with the money of another exactly according to its gold equivalent. (Fluctuations because the money of a country is in silver, or depreciated paper currency, are domestic questions which do not pertain to the present discussion.) As in the case of general merchandise, so with bills of exchange, slight oscillations are always occurring in the supply and demand which cause the price of bills—namely, the rate of exchange—to vary. Dealers who anticipate a change in the rate will buy or sell bills speculatively, as would a dealer in any other commodities. But the par value tends to right itself automatically. For—to continue the Odessa example—if owing to a slackness in the demand for British goods there be more sterling bills on London than there are buyers for, the price falls to a discount; the export of merchandise is discouraged, and the purchase of British goods is encouraged, as Russian merchants can buy sterling bills cheaply and so neutralise some of the tariff impediment. And the same over-supply in Odessa of bills on London which causes a discount there produces in London a premium on bills payable in Odessa, so that an English merchant is encouraged to ship goods there because he can sell at a premium the bills he draws against each cargo.

The greater the inequality in the exchange of goods, the greater becomes the discount and premium respectively, the bills being the mere instruments which enforce the inexorable rule in any country, that if imports are prevented or impeded exports are immediately restricted, the country that imposes the barrier being the one to pay the penalty. But the Odessa banker, notwithstanding the excess of Russian exports over imports, is still willing to buy the bill for a good price if he has other customers for it. He may sell it on

"Change" to a banking agent, who wishes to send it to St. Petersburg to make up a remittance to London for interest on Government bonds, or for paying the rent, interest or dividends on British investments in Russia. Or possibly he may obtain a better price by selling the bill for commercial purposes. An Odessa wine merchant, who has bought claret and brandy from France, wishes to remit money in payment, so he buys the corn bill, endorses it to the wine-grower, and sends it to Bordeaux, for he has to pay in francs, and he sees by the daily-published lists of exchange-rates that the value in that city, measured in francs, of English sterling bills, is good. The wine-grower, on receiving the bill, endorses it over to his banker, who credits him with its value and resells it. The exchange price may not, however, be due to a great demand for remittances to England, for Bordeaux may be sending more wine than she is taking English goods in exchange, but there is a brisk import of Saxony woollens, and the bill is again endorsed, and is sent off by a dry-goods merchant to Chemnitz to pay for hose. By this time thirty days of the bill's course has run, and its value has increased as the allowance for interest becomes less. On its arrival in Saxony it is purchased by a wholesale dealer in colonial produce, who has to remit to Amsterdam payment for a large consignment of Java coffee which he has bought. Norhing is more acceptable in payment than a sterling bill on London. Finding that all the space on the back of the bill is already covered by endorsements he gums on a further six inches of paper (*allongement*) and writes his name. In Amsterdam the bill is bought by a banker who keeps it a few weeks, and then sells it to a Dutch railway company which has purchased some locomotives in Manchester, and has, by agreement with the manufacturer there, to provide money at a London bank to pay cash against bill of lading. So that at last the cargo of wheat is settled so far as the two countries are concerned by a Dutch transaction, and the balance of indebtedness is adjusted. It will be seen that the bill, though it has taken a tortuous route, has, to use a scientific illustration, followed "the line of least resistance," and going at each stage in its journey to the place where London bills are in demand, automatically found its destination with those who are willing to buy British manufactures. In short, the Russian wheat-importer, being prevented by his country's fiscal system from selling his bill directly to an importer of British goods, has, through the machinery of foreign exchange, found a substitute.

The foregoing is by no means an exceptional case. On the contrary, the course of such bills and their effect are frequently much more intricate. But before referring to other incidents, the reasons which give to bills on London their pre-eminence as instruments of exchange may be touched upon. At the very basis of British credit is the traditional belief abroad in the integrity of British traders who, as a class, are known to fulfil the spirit as well as the letter of their engagements. The payment of the bills is in pounds sterling, that is to say, in gold of a specified weight and fineness. There is no risk of payment having to be accepted in silver or currency of fluctuating value. The buyer of a bill, and he who takes it in payment, knows exactly what he is to get. The payment at the date due is certain. It is true that the bill represents a debt, but no one has to be sued or dunned; it is to be paid without question on presentation. When the bills are those drawn directly by bankers on any one of the leading financial houses in London, experience has shown that such bills will be honoured, the per-centages of failure in this respect being so minute as to be hardly worth consideration But, in the case of bills drawn on mercantile firms who may not be known to those who buy the bills, it is necessary to remove even the smallest feeling of uncertainty. In the case of the corn bill, the Odessa banker knows that actual value is represented; for he is acquainted with the customer who draws the bill, and is aware of all the circumstances. But the subsequent buyers of the bill have no such knowledge, and might hesitate to rely absolutely on the means and good faith of the acceptor. No room must be left for doubt, for, at each transfer, full value in money or merchandise is irrecoverably given, and there is no margin for risk. It is not always enough to know that, in case of the bill being refused acceptance, or of being dishonoured by the acceptor, the endorsers are liable. There is probably an ultimate security in this, but delay and expense would be involved, if the bill had to retrace its journey, each endorser paying to the one who took the bill from him, and recovering from the previous endorser.

There must be an immediate remedy in London that will maintain the prompt cash value of the instrument. Therefore, the original banker, in whose favour the bill is

drawn, and who intends to use it as a negotiable instrument, clenches the matter, by adding a guarantee beyond that of the actual parties to the bill. This is one of his functions as banker, and the risk is incident to his business. This guarantee is effected as follows. Almost all foreign bankers keep a moderate amount of money, or, what is as good, credit in London, which, though inadequate to pay all the bills drawn in their favour and bearing their endorsement, is quite sufficient to protect them all by paying in the very rare and occasional instance of the acceptor failing. At the bottom of the second of exchange, which is the negociable copy of the bill, is inscribed, "The first and in case of need with Messrs. Blank & Co." The first part of this inscription is, as already mentioned, a mere direction as to where the accepted "first of exchange" is to be obtained; the second part informs all concerned that Messrs. Blank will, for the honour of the first endorser (the Odessa banker), pay the bill if the acceptor fail to do so. So immediate is this payment, that the numerous endorsers of the bill need never know of the temporary default, and they have no concern in the subsequent steps that may be taken by Messrs. Blank to enforce payment from the acceptor, and, he failing, from the original endorser, the Odessa banker. Not only, however, has the Odessa banker given the "in case of need," but some of the other bankers, through whose hands the bill has passed, have added theirs also, so that when the endorsed copy, or "second of exchange," reaches London, it may have two or three such inscriptions, each giving a separate name in London.

It will be seen how important this guarantee is to all concerned. To the traders, because the value of the document for which they have exchanged merchandise is ensured; to the bankers, because their credit is maintained. If delay or doubt once arose, the negociability of future bills bearing their impress would be endangered.

Besides the bills that are sent to London by the buyers and sellers of merchandise, a large proportion reach their destination in parcels from the foreign bankers who have purchased them, and who thus maintain in England sufficient funds to meet the drafts which they make from time to time. Indeed, this mode of procedure is increasing, and the proportion of commercial bills remitted directly by traders tends to decrease. For those in foreign countries who have to make purchases in England, often find it more convenient to open a credit through a banker in their own country than themselves to purchase bills to remit direct to the manufacturer or merchant with whom they are dealing. By this course the banker, through his London agent, acts as the buyer's intermediary, and protects his interest by paying over the money or accepting a bill in London only against a bill of lading. But all the same, the money paid in London is the product of bills drawn in a foreign country against merchandise; bills which have a negociable value in that foreign country only because British goods are to be imported, although not necessarily into the country where the bill is drawn.

There are also merchants who may be called merchant-bankers, whose transactions are so large and widely spread that they may be able in their own house and its numerous branches to do a reciprocal trade, that shall effect the balance above described. A small merchant or dealer often finds it expedient to sell his produce or his merchandise to such a firm, instead of himself seeking a customer in a foreign country. If the business of these large houses could be disclosed, it alone would illustrate the process which it is attempted here to describe.

In making remittances, especially of large amounts, for precise sums, it is not always practicable to obtain a parcel of commercial drafts which give the desired total. But, as already stated, most foreign bankers, even those who do not make large drafts, have funds in London against which they can draw cheques of moderate amounts to make up differences. Bills of small amounts are also supplied by those which tourists draw on London against the letters of credit or circular notes which they carry with them. Cheques drawn by tourists are, as a rule, readily cashed if they are on an English and (by preference) on a London bank. Or the dividend warrants which a British resident abroad has had sent to him from home may, after he has endorsed them, be cashed by a local money-changer who, treating them as London cash instruments, will re-sell them to importers who have to make payments in England or elsewhere. Other small bills are those of retail shopkeepers and agents, who have sold goods of trifling amounts to English buyers. But a need for small currency, which shall be international in its character, has often been felt, that is to say, currency which will be received by bankers, money-changers, and others in all

important business centres. Post-office orders are not always convenient, and those for foreign countries involve considerable commissions. In Europe the want of small currency has occasionally led to the use of Cook's hotel coupons. Although these range in value from small sums of a few shillings and upwards, they are in effect bills of exchange, as they are payable in London on demand, and in sterling. Although generally cashed for the hotel keepers by Cook's branch agencies abroad, money-changers will also buy them from the hotel keepers, and not only include them with bills of larger amount to make up an exact sum for remittance to England, but there is no reason why they should not send them to any part of Europe. But whether sent to England direct by Cook's own agents, or by an indirect course, they form part of the aggregate flow of value in both directions. The first holder, the British tourist who originally bought them in London, has purchased with them food or lodging on the Continent, but, by the inexorable and automatic law of foreign exchange, these purchases have been met by the foreigner buying British goods.

There is a reciprocal current of credit notes expended by foreign tourists in England. The money spent by American travellers in Europe is greatly in excess of the expenditure by European travellers in the United States, and this not only in mere travelling expenses but in the purchase of goods, advantage being taken of the much lower prices that prevail. Clothing, jewellery, trinkets, and all kinds of personal wares, are bought to such a large amount as to tell considerably on the exchanges. But while the credits on London, purchased in New York by intending travellers, are drawn against the produce shipped to Europe which appears in the Board of Trade returns, the credit notes do not appear, nor do the goods purchased and taken home as personal baggage. The examples given here of the kinds of bills payable in London are, from a banker's point of view, few and incomplete. Treasury bills, issued by the British Government, and due six or twelve months after issue, are largely held on the Continent, and are applied to the payments for British goods. So also are bills drawn on London at military or naval stations, or by captains of British war-ships in foreign ports. Such bills are freely bought by merchants and bankers, and reach London after passing through many hands as already described. But for the limited purpose of this paper the examples given may suffice. Besides the certainty in regard to the time and manner of payment of sterling bills, the vastness of the trade concentrated in London has made that city an international clearing-house, and, as already noticed, it is found convenient by foreign as well as British traders to settle all transactions there. And this applies, as will have been seen, to transactions entirely foreign, sterling bills being used as international instruments for purchases and sales between foreign countries, having nothing of the British element in them. This is no small advantage to Great Britain, because, as it is generally easier to buy bills or credits on London than on any other city, a preference will be given to British manufacturers when purchases are thus facilitated; and as all money dealers abroad are obliged to keep in London money or its equivalent, there are large balances available on moderate terms to English borrowers, and the rate of interest is low.

It is endeavoured here to show that what is generally spoken of as the balance of trade is regulated automatically, that the commerce in foreign bills serves as a gauge or measure to record it, and that neither Parliament nor Congress can in the long run divert the natural flow of trade, although they can, by mischievous interference, impede or restrain it. To diminish imports while increasing exports is the ideal of many traders, who do not recognise that the placing of barriers in the way of values coming in, is in effect the checking of customers who are coming to buy, and whose products form the purchase money.

The Board of Trade returns of imports and exports are often studied to see how the balance of trade stands between Great Britain and other countries, and one reason for the misunderstandings that arise is, that the balance is hardly ever entirely a direct one, and that a third country, or the trade of many countries, has to be brought into the account in order to complete a proper statement. Or, in other words, the total exports and the total imports must be set against each other to ascertain the real condition of affairs, and to judge of the wisdom or otherwise of a particular policy. Let it be assumed that a particular country is sending to Great Britain merchandise to double the value of what she buys as shown by the official returns. First, it must be remembered that the amounts shown in the returns need qualification. The value of British exports is declared as the value at the port of departure, and the freight which is

received by the British ships that carry the goods has to be paid by the foreigner, so adding considerably to the total sum received by this country, a sum in excess, therefore, of the mere free-on-board value. It is further to be remembered that exports include capital investments or loans, no immediate balancing of which is expected, but for which profit or interest is looked for in the future.

On the other hand, the value of imports as entered at the British Custom-house is the value delivered at the port of arrival, and the freight earned by British carriers has to be deducted before the net sum paid to the foreigner can be ascertained.

Secondly, the imports into this country are swollen by the tribute, *i.e.*, the interest or profit just referred to, that has to be sent here in the shape of dividends on loans and other British investments abroad.

Thirdly, and this is the point it is desired to emphasise here, the balance of trade may appear to be largely against Great Britain in regard to a particular country even after making allowances as above, and yet the balance be really in her favour.

If an exporting country, by its prohibitive tariffs or otherwise, refuses to buy from Great Britain as much as it sells, it must find a substitute in someone else who will buy, so as to redress the balance. If this is found to be the case, then the apparent adverse balance will be explained and neutralised. To take a concrete case; if after making all the allowances for freights and interest on investments just referred to, the purchases by Great Britain from the United States were to exceed the sales to that country by £5,000,000 per annum, there would be a full compensation for the apparent loss if the United States, in order to make these excessive sales, were obliged to find some other country or countries more complacent in regard to purchasing from Great Britain, who took British goods in preference to those manufactured in America. It is endeavoured here to show that such compensation does really take place.

London is the great meeting place and exchange for values between East and West, a large proportion of the trade between the United States and Asia involving a flow of bills through London. This affords another example of the indirect course of foreign exchange. Large quantities of Chinese tea are imported into America, as also spices and other products from British India. The exports of the United States to these countries are not sufficient to balance the imports from them: the petroleum, silver, raw products, certain kinds of cotton cloths, a few other manufactured goods, and small wares that America is able to send there not equalling the drafts that have to be met. For the principal manufacturers of the United States have so large a market at home, that they prefer to maintain high prices there which are unattainable in neutral markets, and are content to leave the supplying of manufactured goods to the East in European hands, mainly in those of Great Britain. In 1889 (the latest year for which published returns are available for reference) the United States imported from the East Indies, Australia, China, and Japan produce and merchandise to the value of £12,250,000, while the total export to these countries only amounted to £5,500,000. And as it may be assumed that the United States have little revenue due to them from investments in these countries, the difference has to met in some way. Therefore, in order to pay for tea and Indian goods, the American importer instructs the exporter in these Eastern cities from whom he has bought, to draw for payment on London houses with whom he has arranged to meet the drafts. He provides the necessary funds in London by exporting American produce to England, or by buying the produce drafts on London originated by others. The proceeds of these Eastern bills drawn on and payable in London are used either by the native merchant in India or China or by some other merchant in these countries, who has purchased them for the purpose, to pay for British manufactures. The original drawer generally desires to sell them, for like the Odessa corn merchant, he wants payment at home. There is a limited number of financial firms who have houses in Chicago, New York, and other American cities, as well as in London and Paris. These firms have corresponding houses in the East, or in London trading with the East, and are able to grant credit in either direction to American, European, or Eastern merchants. It is these banking firms who collect, exchange, and distribute the drafts based on the merchandise, and for this reason the traders who avail themselves of their services are often not aware of the machinery which deals with the international exchange transactions.

In regard to South America also exports thither from the United States of flour, oil, ice, timber, and other products do not always suffice to pay for the coffee, hides, sugar,

and diamonds that she buys. Thus, in 1889, the United States imported to the value of £12,000,000 sterling, and exported thither only £2,000,000, and the United States has therefore to adjust to her indebtedness by means of bills or credits based on European (largely British) exports of railway material, iron, steel, or soft goods. These bills or credits are, as in the case of the Chinese and Indian trade mentioned above, paid for by shipments of American wheat, pork, cheese, copper, and other native products to Great Britain.

It will be seen, therefore, that the United States, when their imports of British goods do not suffice to repay them for all the produce they have shipped to Great Britain, are obliged by the automatic action of foreign exchange to find substitutes to purchase more British goods; and Huddersfield woollens, Bradford merinos, Manchester calicoes, Middlesborough steel, and Leeds machinery, go to pay for a corresponding balance of coffee, tea, and spices consumed in the United States but unpaid for by American exports to these countries.

But though by barter of goods trade must, in the long run, be made to balance through the machinery of foreign exchange, the commerce in bills does not always suffice for sudden or spasmodic alterations. In these cases gold and silver and saleable securities come into use to reduce the differences. Thus, in the spring of 1891, there were, in view of an impending increase of Customs' tariffs in the United States, larger shipments thither of merchandise than could be paid for by American produce, and much gold had to be shipped to Europe. Not only the shipment of gold, but the sale to British purchasers of railway and other bonds was encouraged, for every instrument that had a money value in London was in demand. No record of such sales appear in the Board of Trade returns. In the following autumn there was a lull in the shipments from Europe, because the spring surplus was not yet consumed, the tariff alterations had diminished or stopped the flow of certain goods, and the compensating growth of other kinds had not fully taken effect. Besides this, the extraordinary shipments of wheat to Europe caused a flow of gold back again, and the re-sale of American securities by British holders was encouraged. Such movements of the precious metals are only temporary, and, like water, finding its level slowly, because through tortuous channels, so does foreign trade at last balance by the flow of merchandise. Boxes of British sovereigns or American eagles pass backwards and forwards, as make-weight, and frequently remain unopened in bank cellars till they are needed to make another journey back again. The stock in State and municipal debts is transferable; the creditors, to whom interest must be paid, may be either national or foreign; and such creditors may become more or less national or foreign under the stress of the balance of trade. The purchase and sale of United States bonds and shares, and corresponding dealings with European securities, are taking place every day, the demand and supply and the prices being considerably affected by the course of exchange. There is, necessarily, a constant ebb and flow; but as, in the long run, the aggregate holdings of British investors do not diminish, the real balance of trade is not against her. And, in the same way, notwithstanding the movements of bullion, the stock in Great Britain does not year by year become less.

Although, as a nation, the United States has elected to forego a foreign export of manufactured goods, preferring to pay high wages at home to balance the high cost of living, rather than manufacture under normal conditions at a price which will command a foreign trade, there are manufacturers there—growing in number—who are not content with this exclusion from the world's commerce, and who are attempting to influence legislation in their favour. The making of treaties has been authorised by which foreign countries shall be bound to give a preference to high-priced American goods over those offered more cheaply from Europe, the inducement being that produce from these countries shall receive from the United States a corresponding preference by discriminating tariffs imposed on produce from other lands. This policy is most likely to succeed with Canada and the West Indies, whose contiguity to the United States renders the latter desirable as a market for certain kinds of produce. It remains to be seen whether the advantages offered by the United States are worth the price demanded, and how far this attempt to divert the natural flow of trade will succeed, and if it does succeed, its effect on foreign exchange. Commodities ultimately find their destination according the wants of the consumer, and low-grade coffees from Brazil will not shut out the better kinds from Ceylon, even by being cheapened; nor is it likely that the railway companies of South America will consent to pay high prices for American loco-

motives, or Brazilian workmen to pay dearly for American cutlery, because the coffee of their countrymen finds a preferential market. It is more probable that in regard to these countries the increased imports from the United States will be in the form of petroleum, canned meats, and similar produce.

In England also, some manufacturers propose to influence legislation in the direction of "Fair Trade" which shall divert the natural flow of merchandise, and give a preference to those countries which will buy the Britsh goods the fair traders are personally interested in; the inducement offered being a preferential importation of agricultural produce from these countries by taxing the goods of all other countries. The extra cost thus incurred would have to be borne by the British people in general, while the benefits would remain first with the manufacturer interested, and, secondly, with those in this country who can furnish agricultural produce, and whose prices would be immediately raised when the competitive imports were restricted. This, though it might improve rents, would do so at the expense of the consumer.

"Imperial Federation" is another plan of obtaining the same result. The growing cry for federation is natural and patriotic, but there is so universal an agreement on the desirability and advantages of a closer bond between Great Britain and her colonies for mutual defence, that the zeal of those who advocate it would be better employed in formulating a feasible plan, for up till now, unfortunately, the loudest support has been given by those who take advantage of this popular cry to promulgate their "fair trade" theories under the guise of a British Zollverein. By this they mean a system of reciprocal treaties with the Colonies on the lines just indicated, and which, it is hoped, will produce like results. It has, however, been sufficiently shown that the Colonies will not consent to any such plan, and this for two main reasons. Firstly, because the duties Great Britain would be willing to impose on countries outside the Federation—probably 5 or 10 per cent.—would be quite insufficient as an inducement to the Colonies. Secondly, because those in the Colonies who influence legislation—the working classes in the towns—would not see that any benefit would accrue to them by such a system. Although in Australia the protection of local manufactures is favoured, and the cost of imported goods enhanced, the working-men voters would not consent to "discriminating" duties which would give a preference to British manufactures over those from America and Germany. For even if it can be imagined that Great Britain would tax the copper, and wool, and mutton from countries outside the Federation, for the supposed advantage of the colonists, it would be the colonial landowners, the squatters, and the capitalists who have such mining and agricultural products to export that would gain all the benefit. As a matter of academical discussion, however, it might be interesting to consider how such treaties, if put in practice, would affect the exchanges.

It will be seen how difficult it is to touch at all upon the subject of bills of exchange, without referring to the goods they represent. The desire to shut out the foreigner from supplying the home customer is common to all manufacturers and shopkeepers everywhere. The sight of foreign wares on shop counters is palpable, and touches keenly the home producer with whom they compete; while the effect on an export trade of restricting imports is too remote, and does not present itself so vividly to the imagination. This is not to be wondered at in those who are occupied in making or selling British goods for use at home, and who measure the prosperity of the country by their profits from such business. But those who manufacture or sell for export, should realise that there must be a return current, if trade is to be maintained and encouraged.

The principles here put forward may, to those who are familiar with them, appear truisms, which it is a waste of time to enunciate. This country, it may be said, is too firmly established in free trade to need any arguments on the subject. The author ventures to assert that this view of the subject is erroneous. Directly there is a depression of trade, the discontent —which has only been dormant during prosperous times — becomes widespread and aggressive. In the manufacturing districts especially, the majority—master and workman alike—look only at trade from their individual standpoint, instead of from a national point of view. Such persons would probably support the abstract desirability of restriction, although they might not venture to formulate a plan. The present example of France should be a warning, for in that country this view is being logically applied. It is to maintain existing investments that a burden is being inflicted on France, which, in its crushing effect, will

be almost as bad as a war or a pestilence. In this country the real impediment to retrogressive legislation does not lie in any universal opinion that restriction is bad, but because first it is obviously undesirable to make food and raw products dearer; secondly, that if they were left still free of duty the balance of imports available for taxation is hardly worth consideration; and thirdly, that if manufactured goods were taxed at the Custom-house there would be a great disagreement in regard to which were to be taxed, and how, for the finished product of one industry is the raw material of another. So that, if even there were an agreement as to the principle, there would be fortunately no chance of agreement in the application of it. It is true that if the tariff be exclusively or specially directed against a few particular commodities, they may be restricted or even entirely shut out. But such a course only diverts the current of purchase to some other articles, for the country as a whole must somehow receive payment for its exports.

The old fallacy that an excess of imports over exports is a disadvantage to any country as making "the balance of trade" against it, may be modified or removed if it be noticed that an excess of exports is only to be seen in poor countries. Great Britain in 1890 imported merchandise to the value of £420,000,000 and exported £382,000,000. France, also a rich country, imported in 1889, £172,000,000 and exported £148,000,000. The United States, a rich country, but with great indebtedness to Europe, had her imports and exports nearly equal £152,000,000 to £155,000,000. Russia, which is a poor country, importing only £37,000,000, had to export £68,000,000 to adjust her indebtedness abroad. But occasionally there is the apparent anomaly of a poor country being able to import largely. Thus the Argentine Republic, in the six years ending 1889, imported £138,000,000 and exported only £105,000,000, but this arose from the very large investments of European capital, mainly on account of loans and public works. If left to her own resources the excess would have been the other way, as is now the case, when investments have ceased. In the years 1871-2, after the Franco-German war, there was a similar excessive flow of British capital to Central and South America with a view—not altogether realised—of obtaining interest or revenue in return. Not only, therefore, is it necessary to regard the trade of many countries in order to arrive at the condition of any one, but the trade of many years must be averaged if trustworthy results are to be obtained.

The peculiar effect of heavy tariffs is shown in the woollen trade between the United States and Great Britain. Every wool-producing country can only, because of climate and breed of sheep, produce certain kinds of wool. In Scotland, districts only thirty miles apart are dissimilar, and the wool in Shetland is unlike that in Yorkshire. The wool in the United States is again different, and for certain goods is more suitable than wool obtainable anywhere else. But Australia, New Zealand, and Buenos Ayres produce other special kinds; while the merino of Australia gives another variety. These countries grow more wool than all others put together. In Great Britain enormous quantities of each kind are available; the manufacturer is free to choose from all the varieties, each for a particular cloth, or can combine them in any proportion. In the United States, on the other hand, a manufacturer finds that the price of native wool is enhanced by the protective tariff on competing kinds, and if he desires variety, a study of the tariff book restrains him from buying the foreign wool. Being thus impeded, the practice and skill for making good cloth are not acquired; and notwithstanding an import duty, ranging from 50 to 150 per cent., Yorkshire woollens continue to be profitably exported to the United States, while the manufacture there is in a depressed condition. It is true that when the tariff has been directed against the rough cloth, for which American wool is suitable, it has succeeded in diminishing the importation of foreign cloths of a similar kind; and the British manufacturers who formerly supplied them have been led to direct their attention to medium and finer grades, where the use of highly skilled labour is repaid. The shutting out of the cheaper kinds of Yorkshire woollens has, by removing competition in America, enhanced the price of workmen's clothing there, but in regard to the finer kinds which must come from Europe, higher prices have only moved a little upward the stratum of society which can afford to be well dressed; more medium woollens have superseded the finer kinds; and the purchase of clothes in England by American travellers is encouraged, as already referred to. The clothing taken in the baggage of the travellers makes the real total of woollens exported greater than the apparent total shown in the Board of Trade returns. The export of certain kinds of woollens

from the United States to Europe, which would certainly take place if there were free exchange, is prevented, to the loss of both countries.

This system of disturbing the natural flow of trade and making artificial prices loads even the natural products of the country where such a system prevails. Meat and grain and vegetables, which are cheaply produced in the United States and sold at low prices in Europe, are dear to the American retail purchaser, because directly these products leave the cars or vessels which bring them to the large cities, the expenses of rent and salesmen's wages so increase the price that good meat and bread are as dear in New York as in London, and Florida oranges are dearer.

The transference of manufactures from one country to another under the stress of hostile tariffs, has sometimes curious results, not immediately apparent. The United States, in their desire to be a self-contained nation dependent only on themselves, welcome any foreigner who will bring skill and capital to employ local material and labour. Undoubtedly the tariff, if made stringent enough, tends towards this result, although sometimes it is difficult to transplant effectually industries which have had the advantage of traditional and hereditary skill, and the benefit of numerous preparatory and subsidiary trades which have grown up around them. But there is also a return current. The genius of inventors and manufacturers in the United States cannot always be satisfied with the home market, and some among these classes desire to compete with European manufacturers in the neutral markets of the world. Great Britain and her dependencies alone offer a wide field. Not only in Liverpool and London, but in Calcutta, Hong Kong, Cape Town, and every British colony would American goods find a market. American ships and cargoes would be received as freely at all these ports as British vessels and cargoes, neither harbour dues nor Custom duties being heavier on the one flag than on the other. If foreign exchange were allowed free scope, there would be a mutual trade, to the advantage of the world; but the tariff in the United States holds back her export vessels as surely as if they were tethered to the shore by unbreakable steel. There are only three methods by which American manufacturers can sell their goods abroad, but, as yet, only two of these methods are adopted. One is, by selling them at less than a usual profit or without profit. American watches and sewing-machines can be bought in England at lower prices than in America, because some of the cost is imposed on the goods sold at home, where the price is protected. The same system has been applied on the Continent. Germany sells steel rails to Italy and Spain at less prices than to the German railways, the latter being charged an extra rate per ton to provide a profit on what has been exported.

The second method of finding a foreign market is to transfer the manufacture thither; so that, while the British manufacturers of silk plush, sewing-cotton, and printed books, set up workshops in America to supply high-priced goods, the American manufacturers of steam-boilers, sewing-machines, mining machinery, and steel screws cross the Atlantic, and employ British material and labour in London, Glasgow, and Leeds, for goods destined for the whole world outside the United States, and send to these British cities for execution the foreign orders they receive at home; orders which, under normal or free conditions, would naturally be executed in America. Bounties on export form a third resource. The drawback granted to the French sugar refiners is in effect a bounty, with the result that French sugar can be bought in London or Leeds for half the price charged for it in Paris.

It is in vain to struggle against the inevitable. In Russia, thousands of tons of wheat have rotted at remote railway stations for want of rolling stock. Prohibitive tariffs have prevented the importation of wagons, and the home manufacturers cannot supply the need. In Australia may be seen, on a small scale, the same futile attempt. A reluctance to buy from Europe what the working-class voters think they can make at home, induces them—not only in Victoria, but in New South Wales—to promote the establishment of factories on an impossible basis. The railway traffic of these Colonies has been hindered, while attempts have been made to manufacture locomotives and railway material in the Colonies. These attempts have failed, just as have those for manufacturing iron, steel, and woollen goods under abnormal conditions. And if success could even be imagined, any reduction of such imports must cause a proportionate falling off in their exports of wool, copper, and wheat, the prices of all these commodities suffering a corresponding reduction in price by the competition of producers under a diminished demand.

Those who are discontented with the balance

of trade have constantly before them an awful chimera, an imaginary future when protective tariffs abroad will have become so universal and prohibitory as to shut British goods out from all foreign markets. Then, it is feared, will come a time when Great Britain will have to pay in gold for all she buys abroad; and, indeed, the continued shipments of bullion from England are looked upon with suspicion. London is the centre of the bullion trade, and much of the gold and silver imported from mining countries has been brought here to be re-exported. In 1890, Great Britain imported £34,000,000, part of which was sent her as interest on investments, and the remainder as payment for British merchandise. About three-fourths of the £34,000,000 was re-exported, the difference serving to maintain the coinage, and for use in manufactures. And as the amount of gold in this country does not tend to diminish, those who look with anxiety on what they deem an excess of imported merchandise may be reassured. The sufficiency or otherwise of the reserve stock of gold coin in this country which exercises the public mind at present, does not pertain to the present discussion. These gloomy predictions are based on the fallacy that gold and silver are in themselves real wealth, instead of merely being the instruments of expression for property of a reproductive nature. When Spain and Portugal discouraged manufactures, and endeavoured to live upon the huge importations of gold and silver from their colonial possessions, their fall had commenced. The very countries which most impose restrictions on British goods—France, Spain, and the United States—derive a considerable portion of their wealth from their exportations to Great Britain, and take all their payment in manufactured goods; and if more effectual restrictions were imposed, bills on London drawn in these countries against exports would only be saleable at a discount; and unless some substitute could be found, as already described, the export trade would be so impeded, and prices so fall, as to compel a reactionary policy. The evil works its own cure. France and Spain must send somewhere abroad their wine and silk, America her agricultural produce, and, as there is not enough gold in all the world to pay for them, hey must accept payment in kind. The circumstance that such interchange or barter is disguised by the methods of foreign exchange does not alter the real fact.

Great Britain will decay, or her population decrease, when, through exhaustion of her minerals or decadence of her people, she can no longer manufacture, and not before; for so long as she is able and ready to buy, there will always be willing sellers, who must perforce accept the buyers' terms.

DISCUSSION.

The CHAIRMAN said it might appear, at first sight, as if the platform of the Society of Arts were not so suitable a place for a paper on this subject as some others, such as the Gresham College or the Institute of Bankers, at which a course of lectures on foreign exchanges had recently been given; but it must be remembered that their full title was the Society for the Encouragement of Arts, Manufactures, and Commerce; and it was found that, in the past, those nations which were pre-eminent in art were also successful in commerce; whilst commerce depended on manufactures, and they, in their turn, were largely dependent, not only on the useful, but also on the elegant arts. The consideration of the subject, with which these three mutually interdependent factors were so closely connected, was therefore by no means out of place. Looking forward to the World's Columbian Exposition at Chicago, to be opened in about a year's time, which had already begun to cast its shadow before, he took it that its great object was not merely to produce the greatest show on earth, but to develop the interchange of commodities, and a desire for the acquisition of the products of various nations. That Society was peculiarly charged with the representation of British interests at the Exhibition; and it would be the duty and pleasure of the Council, acting as a Royal Commission, to see that Britain obtained its full share of commerce likely to be developed by means of that Exhibition. It was always perilous to venture on a definition, but he should be inclined to say that foreign exchange meant the art of transferring, not gold, but the command of gold, from one country to another. Gold itself entered but in a very small degree into the ultimate settlement of transactions, and even the extent to which the settlement was performed by gold was extremely obscure and difficult to state precisely. With regard to wholesale transactions in the import and export of precious metals, the official returns were very misleading, and a reference to them would not lead to accurate results. Even in the case of France and England, the official figures in each country were by no means in agreement. With regard to retail transactions, the export of gold in the pockets of tourists, was very obscure. He had lately made some inquiries on this subject, and had received information from the United States Government, and had also made inquires on this side as to the probable amount exported from England in the hands of emigrants and re imported into England by the upper class of American tourists, and he

found that in the case of the largest credit issuing-house, not more than 10,000 sovereigns were required in the course of the tourist season. With regard to the amount taken away by emigrants, he had not been able to obtain any accurate information, or even to form any satisfactory estimate. The vast majority of operations between various nations was conducted by bills of exchange, which were held by some to have been invented by the Jews, who came to this country shortly after the Norman conquest, and who, when they were expelled, had recourse to this device for securing the transfer of their capital. They, undoubtedly, drew bills in respect of the wool shipped from England in payment of Peter's pence, and also legitimate commercial bills of exchange against similar exports. In those days a bill of exchange was a very solemn document. One of the earliest known examples was dated 28th April, 1404, from Bruges; it began "In the name of God, amen," and required the person to whom it was addressed to deliver to so-and-so, so many Barcelona scudi, the equivalent of which the drawer acknowledged to have received, and ended with a prayer that God would watch over the drawee. The minute details of the course of exchange formed an apparently intricate and, to most people, rather forbidding subject. If English coinage was all in sovereigns, and that of all other nations in pence, it would be easy to see whether there was a premium or discount on the exchange, if in the one case 245 and in the other 235 pence were given for the sovereign; but actual transactions were much more complex. In the case of France, sovereigns were dealt with in terms of francs; in Russia we did not convert the sovereign into the coinage of the country, but, as in India, calculated the number of pence given for the silver coin of the country. In Spain the practice was even more absolete. The paper dealt rather with the general course of transactions, of which a very good synopsis had been given. Mr. Matheson had shown himself to be not without some bias on the question of bimetallism and monometallism, but as having strong views on the subject of protection. fair trade, and free trade. It would take too long to go into those questions, but on the matter of the foreign exchanges there was room for a good deal of discussion.

Mr. C. M. KENNEDY, C.B., said the account given in the paper of the complex nature of mercantile transactions and the balance of imports and exports, and the real character of Custom-house valuations, seemed to him not only accurate, but very well put. With regard to the tariff question, what the United States had done had been to take off the duties from sugar and some other commodities, and then to say that they would be re-imposed, unless the countries which sent those goods to the American market made what the United States Legislature termed reciprocal arrangements, the object being to obtain preferential terms for American manufactures. That policy had succeeded in the case of Brazil, where a Treaty to this effect is now in force; in the case of the Spanish West Indies he was not yet certain whether a similar policy would prevail in the case of the British West Indies. A reciprocity arrangement had been concluded on behalf of the Colonies, but goods from the United Kingdom remained on precisely the same footing as United States goods. He thought Mr. Matheson was in error in thinking that Canada was likely to come into an arrangement o this kind with the United States, for he knew of no indication of it at present. It could hardly be said that the British colonies would not consent to what might be termed a British Zollverein; no definite plan of that sort had, as yet, been put forward, but proposals had been made on the part of Canada; and the colonial allegation was that the obstacle is the stipulation in some commercial treaties, which obliged our Colonies to admit the goods of certain foreign countries at precisely the same duty as they did the manufactures of the United Kingdom. As regards France, it was too soon yet to say what the effect of the new tariff would be. An interesting discussion would probably arise on these questions on Mr. McCormick's paper next week, and on one by Colonel Howard Vincent, in May. It must be remembered that those countries which adopted a high tariff system considered that the advantages it conferred on the agricultural, industrial, and shipping interests, by developing important branches of trade, counterbalanced the disadvantages which they fully recognised in the higher prices of particular commodities.

Mr. GEORGE CLARE said he understood the object of the paper was to induce British manufacturers to take a more rational interest in the subject of foreign exchange; both in theory and practice. Up to almost the time of the Franco-German war, the supremacy of British manufactures was nearly absolute and our manufacturers were able to say to the foreign buyer, there are my goods; you know the quality; the price is so and so; and if you want them you must pay for them by a bill on London; and the foreign buyer had to submit. The English manufacturer was then independent—almost too much so—the only competition he had to meet being that of his own countrymen. But all that was now changed. Great progress had been made in manufactures on the Continent, especially in Germany and Belgium; and the result was, that British manufacturers were now subject to very active foreign competition, and the foreign buyer was now turning round, and, as appeared by the Consular Reports, was beginning to say: There are two price lists, one British and one German. The British one is made out in the English language, in insular currency, which I do not understand, and in English weights and measures, which are unintelligible. On the other hand, the German price list is in my own language, currency, and weights and measures. If the goods are of equal quality, why

should I not give the preference to the one which is so much more convenient. If English makers were to hold their ground, they must adapt themselves to circumstances; and he hoped this paper would have the effect of causing them to give more attention to what must eventually be a necessary condition of their retaining their business.

Mr. MATHESON, in reply, said Mr. Clare had made a criticism on the manufacturers of this country which was often made by those who saw more than the banking and commercial side of the matter. But the answer of the English makers would be that they were manufacturers and not merchants; they left, perhaps unwisely, the commerce to the gentlemen who lived in London and Liverpool, who acted as intermediaries, and provided them with that British sterling against shipment which they so much valued. They thought there should be a subdivision of labour, and that the looking abroad for customers and changing English prices into foreign currency, though very necessary, was not their business. They might be wrong in that, but as long as they kept their factories going they could hardly be expected to alter it. It was not all profit to the German manufacturer that in China, Brazil, and other places he had gone past the Englishmen and given those facilities—sometimes in the way of credit, as well as in the ease with which his invoices could be read; and in some cases the German manufacturer was only now acquiring, at great cost to himself, the bitter experience which the British exporter, or his father and grandfather had acquired long ago. There was a good deal to be said on the side Mr. Clare had mentioned, but there was also something to be said on the other side. He was very sorry to hear Mr. Kennedy say that the United States policy had succeeded with regard to Brazil, and thought that sufficient time had not yet elapsed to enable an opinion to be formed. He held it was a fact that a treaty had been signed, but the success had not yet been proved of a system which was radically unsound. His reference to the West Indies was quite general; he did not refer specially to Trinidad, but Jamaica and Canada were the two countries from which he thought some rivalry might be feared. Where there was so much ignorance on this important subject amongst traders, he hoped that even the slight contribution he had been able to make would prove useful.

The CHAIRMAN then proposed a vote of thanks to Mr. Matheson for his paper, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

CHICAGO EXHIBITION.

The following report has been presented to the Director-General by the Hon. Walker Fearn, Chief of the Department of Foreign Affairs:—

Thirty-eight nations and colonies have official commissions actively at work in the interest of the Exposition. These are—Argentine Republic, Austria, Belgium, Brazil, Columbia, Costa Rica, Denmark, Ecuador, France, Germany, Great Britain, Guatemala, Hawaiian Islands, Honduras, Italy, Japan, Korea, Mexico, Nicaragua, Norway, Paraguay, Persia, Peru, Russia, Salvador, Transvaal, Turkey, British Guiana, British Honduras, Canada, Cape Colony, Ceylon, Cuba, Dutch West Indies, Jamaica, New South Wales, Porto Rico, Trinidad.

The Argentine republic has appropriated $10,000 (£2,000), and will erect a special building. Austria has appropriated $149,100 (£29,820), and a commission of the most eminent men of that country is at work. Belgium has made no Government appropriation, but many of the great manufacturing establishments have applied for space. Bolivia has appropriated $30,700 (£6,140), and will make an interesting exhibit. Brazil, through National and State appropriations, has an aggregate sum of $600,000 (£120,000) for Exposition purposes, and will erect a special building. China has not arranged for any Governmental exhibits, but individual efforts are being made for a good representation. Chili, when the Balmaceda Government was in power, set aside $100,000 (£20,000) for Exposition purposes. The matter is now under the consideration of the new Government. Colombia made an appropriation of $100,000 (£20,000) and will have a complete exhibit, and will erect a special building. Costa Rica appropriated $150,000 (£30,000), and will make a complete exhibit in a separate building. Denmark has given no official notice of an appropriation; a Commissioner has visited this country and secured space for a complete exhibit. Danish West Indies will make a complete exhibit. Ecuador has appropriated $125,000 (£25,000) for a complete exhibit in a special building. Egypt has been granted a concession for a street in Cairo and a complete exhibit in special buildings. France has appropriated $650,000 (£130,000), with a complete exhibit of arts and manufactures. Algeria has a concession for a complete exhibit in special buildings. French Guiana will have a complete exhibit of polished woods; Germany has made a preliminary appropriation of $214,200 (£42,840) for the greatest exhibit ever made by this nation at any World's Fair. Three special buildings will be erected. Great Britain has made a preliminary appropriation of $125,000 (£25,000) for a complete exhibit, and will erect four or five special buildings. Barbadoes has granted an appropriation of $6,000 (£1,200), and will make a complete exhibit. British Guiana has appropriated $25,000 (£5,000), and British Honduras $7,500 (£1,500), for complete exhibits. Canada has allowed a preliminary appropriation of $100,000 (£20,000). There will be a complete exhibit of all British North America. Cape Colony has appropriated $25,000 (£5,000), and there will be a thorough representation of all British South Africa.

Ceylon's appropriation is $70,000 (£14,000) for a

thorough and unique exhibit in a special building, India will have a full exhibit, and probably a special building. Jamaica's appropriation is $20,000 (£4,000). New South Wales, and all the Australian Colonies, have a Commission at work, with Government funds, who have applied for 300,000 square feet. Trinidad has appropriated $15,000 (£3,000). Guatemala's appropriation is $120,000 (£24,000). The Hawaiian Islands will have a complete exhibit in special buildings. Hayti will make a complete exhibit. Dutch Guiana's appropriation is $10,000 (£2,000). The Dutch West Indies have appropriated $5,000 (£1,000).

Honduras has appropriated $20,000 (£4,000).

Italy has made no appropriation, but a Commission is at work, and space has been applied for, by the best artists and manufacturers.

Japan's appropriation is $631,000 (£126,200), for the most complete exhibit ever made by this nation, in special permanent buildings.

Korea will have a complete exhibit.

Mexico's preliminary appropriation is $50,000 (£10,000). The Government Bureau and Commission are collecting exhibits.

Morocco has obtained a concession for a complete exhibit in special buildings.

Nicaragua's appropriation is $30,000 (£6,000).

Norway's appropriation is $53,600 (£10,720), for the greatest exhibit ever made by this county at a World's Fair, with a special building.

Paraguay's appropriation is $100,000 (£20,000).

Persia will have a thorough and complete exhibition from Central Asia.

Peru's appropriation is $125,000 (£25,000) for the most thorough exhibit ever made by this country; there will be a special building.

Russia's Government will make the finest exhibit ever made by the Russian Empire at any Exhibition.

Salvador's appropriation is $12,000 (£2,400.)

Spain will have a complete exhibit in special building. Cuba's appropriation is $25,000 (£5,000).

Sweden will make a complete exhibit, as will also Transvaal.

Turkey's concession is for a complete exhibit in special buildings. Uruguay will have a complete exhibit. Venezuela will make a complete exhibit n special building. Greece will have a complete Governmental exhibit of ancient art.

Madeira's exhibit will be complete, as will that of the Orange Free State, San Domingo, Siam, and the Straits Settlements.

Obituary.

Sir Francis Knollys, Bart., F.R.S. — Sir Francis Charles Knollys, whose death occurred on the 19th ult., was born in 1802, and succeeded his father in 1831 as third baronet. He was educated at Trinity College, Cambridge, and graduated B.A. 1825, M.A. 1828, and was called to the Bar in Lincoln's-inn in 1834. In 1871, he read a paper before the Institution of Civil Engineers, on the "Archimedean Screw-Propeller, or Helix, of Maximum Work," for which he was awarded a Telford Premium by the Institution. Sir Francis Knollys read a paper before the Society of Arts, in November, 1873, on a "Method of Refining or Converting Cast Iron into Iron or Steel," and in 1874 he was elected a member of the Society.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

April 6.—Robert S. McCormick, Resident Commissioner for Great Britain from the World's Columbian Exposition, "The Future Trade Relations of Great Britain and the United States." Sir Douglas Galton, K.C.B.. F.R.S., will preside.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

April 7.—Dr. J. Augustus Voelcker, "The Agricultural Needs of India." Sir John Strachey, G.C.S.I., will preside.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

April 5.—The Rev. John McLean, D.D., "The Red and White Races in Manitoba and the North-West." Sir Charles Tupper, Bart., G.C.M.G., C.B., will preside. The paper will be illustrated by lantern slides, and a collection of Blackfoot and Sioux Indian articles.

Cantor Lectures.

Monday evenings, at Eight o'clock:—

Bennett H. Brough, Assoc.R.S.M., F.G.S., "Mine Surveying." Three Lectures.

Lecture II.—April 4.—*Surveying.*—The compass—Ancient forms of compass—Various forms of miner's dials and theodolites—Use of aluminium for mine-surveying instruments—Supply of light for reading the verniers underground.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Bennet H. Brough, "Mine Surveying." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Prof. Wallace, "Agriculture of Modern Egypt."

Scottish Geographical Society (London Branch), 20, Hanover-square, W., 8½ p.m. Inaugural Address by Professor James Bryce, on "The Migrations of the Races of Men, considered Historically."

Engineers, Westminster Town-hall, 7½ p.m. 1. Discussion on Mr. Stephen Sellon's paper, "Electrical Traction and its Financial Aspect."

2. Mr. Reginald Bolton, "The Application of Electricity to Hoisting Machinery."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. C. R. A. Wright, "Specific Gravities for Practical Purposes." 2. Mr. Adolphe Baur, "Artificial Musk." 3. Mr. F. H. Leeds, "Note on Rosin Oil."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Signor Luca Beltrami, "The Construction of the Central Pillars of Milan Cathedral." 2. Mr. J. Starkie Gardner, "Wrought Ironwork: the Renaissance Period."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1a, Adelphi-terrace, W.C., 8 p.m. Professor Bernard, "The Argument from Design."

East India Association, Westminster Town-hall, S.W., 3 p.m. Mr. Herbert J. Reynolds, "The Amendment of the Indian Councils Act."

TUESDAY, APRIL 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Rev. John McLean, "The Red and White Races in Manitoba and the North-West."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Brain." (Lecture XII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. H. Alfred Roechling, "The Sewage-Farms of Berlin."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Edgar A. Smith, "The Land-Shells of St. Helena." 2. Mr. F. E. Beddard, "Notes on the Indian Darter *(Plotus melanogaster)*." 3. Mr. Seebohm, "A recently-described Species of Pheasant from Central Asia."

WEDNESDAY, APRIL 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Robert McCormick, "The Future Trade Relations of Great Britain and the United States."

Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 a.m. Annual Meeting. 1. Address by the President. 2. Mr. B. Martell, "On divisional Water-tight Bulkheads as applied to Steamers and Sailing Vessels." 3. Mr. J. I. Thornycroft, "On Steadying Vessels at Sea.'

Geological, Burlington-house, W., 8 p.m. 1. Mr. Walcot Gibson, "Geology of the Gold-bearing Rocks of the Southern Transvaal." 2. Mr. R. G. Mackley Browne, "The Precipitation and Deposition of Sea-borne Sediment."

Entomological, 11, Chandos-street, W., 7 p.m.

Archælogical Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W. 8 p.m.

THURSDAY, APRIL 24.. SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Dr. J. Augustus Voelcker, "The Agricultural Needs of India."

Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 noon. 1. Mr. W. H. White, "Notes on some recent Experiences with H.M. Ships." 2. Commander E. B. Boyle, "A Ram Vessel and the Importance of Rams in War." 3. Mr. F. C. Goodall, "Whale-back Steamers." 7 p.m. 1. Mr. S. W. F. Morrish, "An Approximate Rule for the Vertical Position of the Centre of Buoyancy." 2. Mr. A. F. Yarrow, "Balancing Marine Engines and the Vibration of Vessels."

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. D. Morris, "The Phenomena concerned in the Production of Forked and Branched Palms." 2. Mr. A. W. Waters, "Gland-like Bodies, &c., in the Bryozoa."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. W. A. Shenstone and C. R. Beck, "Platinous Chloride and its Use as a Source of Chlorine." 2. Prof. Emerson Reynolds, "The Action of Silver Tetrachloride on Substituted Phenylamines."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Colonel Lambert, "Hephaestos, or the Mysteries of Art in the Precious Metals."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. B. A. Whitelegge, "Epidemic Waves." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. A. Reckenzaun's paper, "Load Diagrams of Electric Tramways, and the Cost of Electric Traction."

Historical, 11, Chandos-street, W., 8½ p m.

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p m.

Geographical, 44, Broom-street, Manchester, 7½ p.m. Mr. W. E. Hoyle, "Zoology in relation to Geography."

FRIDAY, APRIL 8...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 noon. 1. Mr. A. Denny, "Some Notes on the Strength of Steamers." 2. Mr. W. Hok, "On the Transverse Stability of Ships, and a Rapid Method of Determining it." 3. Mr. J. H. Heck, "Notes on Experiments with Inflammable and Explosive Atmospheres of Petroleum Vapour." 7 p.m. 1. Mr. R. E. Froude, "On the Theoretical Effect of the Race Rotation on Screw-Propeller Efficiency." 2. Mr. J. G. Liversidge, "Performance of Three Sets of Engines belonging to the Second-class Cruisers recently added to H.M. Navy, as calculated from the Full-Power Steam Trials."

United Service Institution, Whitehall-yard, 3 p.m. 1. Captain Sir Alfred Jephson, "On the Royal Naval Exhibition of 1891." 2. Major L. Edie, "The Arts Section of the Naval Exhibition."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor W. E. Ayrton, "Electric Meters, Motors, and Money Matters."

Civil Engineers, 25, Great George street, S.W., 7½ p.m. (Students' Meeting.) Mr. R. J. Durley, "Some Forms of Petroleum Engines."

Astronomical, Burlington-house, W., 8 p.m.

Junior Engineering Society, Westminster-palace-hotel, Victoria-street, S.W., 8 p.m. Mr. H. G. Dempster, "Suspension Bridges, with a description of the Donyang River Bridge, Assam."

Institute of Architecture, Science, and Art, Dundee. 8 p.m. Mr. W. D. M'Kay, "The Art of the Low Countries."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. William Akroyd, "Note on a Law of Colour in its relation to Chemical Constitution." 2. Mr. Walter Baily, "On the Construction of a Colour Map." 3. Mr. William Gleed, "A Mnemonic Table in connection with Electrical Units."

SATURDAY, APRIL 9...Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. F. Bridge, "Dramatic Music from Shakspere to Dryden." Lecture III.

Botanic, Inner Circle, Regent's-park, N.W., 3.45 p.m.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, APRIL 8, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The second lecture of the course on "Mine Surveying" was delivered by Mr. Bennett H. Brough, Assoc.R.S.M., F.G.S., on Monday evening, 4th inst.

The lectures will be printed in the *Journal* during the autumn recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 6th inst. Present:—The Attorney-General, M.P., Chairman of the Commission, in the chair; Sir Frederick Abel, K.C.B., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Lord Alfred S. Churchill, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K C.M.G., C.I.E., Major-General J. F. D. Donnelly, C.B., James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B , D.C.L., F.R.S., Thomes Hawksley, F.R.S., Alexander B. W. Kennedy, F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., Wyndham S. Portal, Professor William Chandler Roberts-Austen, C.B., F.R.S., and Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, M.A., as secretary.

AGRICULTURAL COMMITTEE.

A meeting of the Agricultural and Food Products Committee was held on Monday afternoon, 4th inst., at 12, Hanover-square. Present: The Earl of Feversham, President of the Royal Agricultural Society, in the chair; R. Bannister, The Earl Cathcart, Major Craigie, Alfred Darby, Walter Gilbey, Captain Heaton, Colonel Sir Nigel Kingscote, K.C.B., Lieut.-Gen. Michael, C.S.I., Lord Moreton, John Thornton, Dr. J. Augustus Voelcker, Sir William Williams, Bart., Sir H. Trueman Wood, Secretary of the Royal Commission, and Ernest Clarke, Honorary Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 29th, 1892; Alfred Gilbert, A.R.A., in the chair.

The paper read was—

THE DECORATIVE USES OF SCULPTURE.

By E. Roscoe Mullins.

There are two recognised ways of looking at the art of sculpture—the historical, and that included in the study of archæology. These two aspects of the art are more alike than at first might be assumed, and the illustrations for the survey of it from the one aspect would serve equally well for the other; for the "science of man's handiwork in the past," which archæology is, includes sculpture, and, in a limited degree, is indeed identical with it.

But there is a third way in which the art can be studied, which, though not so comprehensive as the other two, yet will be found to include most of the important works that have been executed in the past, and to embrace within its fold most of the aims of the sculptor himself, and that is, the decorative aspect of the art.

So important is this view, that I can scarcely understand an ancient sculptor, whether of Egypt, Assyria, or Greece, deeming it necessary to make any subdivision of the art at all beyond it. To him, all, or nearly all, sculpture would be undertaken for purposes of decoration, and though he might allow for a few exceptions, he would not accept it as the rule as we do now, that sculpture should be

executed independent of its destination, and without any direct object in its design.

The same would apply to the sculpture of the great Gothic age of the 11th to the 13th centuries, and also to that of the Renaissance of the 15th, 16th, and 17th centuries.

When the term sculpture was used in the past, it applied to decorative sculpture in particular, but we, however, have unfortunately accustomed ourselves to apply the term "decoration" only to the mere filling up of space with work destitute of any meaning, and without direct purpose beyond that of ornament. The misuse of the term probably dates from the 18th century, in the times of Louis XV., when society was thoroughly disorganised, and was undergoing a great upheaval. At that time art was but an additional luxury to the few.

The importance of a meaning to all the higher forms of decoration is one which cannot be too strenuously insisted upon; and I think, by reference to the examples that I intend to bring before you at the end of my paper, that you will agree with me that, in former great ages of the art, this was always the guiding principle of the sculptor. The false and limited view of decoration held by us of to-day is constantly fostered by the sight of isolated pieces of sculpture, that were formerly parts of a whole, but have been detached from their places (whether by violence or necessity it is not within my province here to discuss), and placed permanently in our museums. Thus, we lose the connection that once existed between them and their surroundings, and accustom ourselves to look at them, and enjoy them too (that I fully admit) purely as separate works, just as one might a book taken down from its shelf; and we are as apt to infer that the pieces of sculpture are as independent of their surroundings as the contents of that book may be to those of its neighbours alongside it, or to the mouldings of the shelf on which it was placed.

The great advantages that we enjoy through the establishment of these museums—and they are quite a modern institution — must not deaden us to their possible evil. As the late Professor Jevons has forcibly pointed out, "the collection of the articles is accidental, and to realise the true meaning and beauty of an object, the spectator must possess a previous knowledge of its historical bearings and a rare power of imagination, enabling him to restore it ideally to its place." "Who, for instance," he continues, "that sees some of the reproductions of the mosaics of Ravenna hanging high upon the walls of the Museum at South Kensington, can acquire therefrom the faintest idea of the mysterious power of those long lines of figures in the Church of St. Apollinaris." Since Prof. Jevons wrote this, the Science and Art Department has done much to supply this deficiency, whereever possible. I do not mean to say, but that in decorative sculpture, much of what we call pure ornament must, even if it had originally any meaning, be now detached from it in its manifold applications to modern buildings; the egg and tongue moulding (whether derived or not from the ancient Lotus, as a writer lately has sought to prove) the Ionic and other capitals, and such like varieties of form, cannot have any definite meaning to us, but serve only to afford pleasing lines to the eye, or to accentuate a space by their richly broken up surfaces; but these, for this very reason, should be looked upon as decoration of a less important order, and by no means representative of decoration as a whole. Wherever possible, an idea should be allowed to assert itself, in however simple a form, and take the place of the oft-repeated panels of ornament, adapted from some architect's stock-book of designs, which now do duty on so many buildings of all descriptions and of whatever character, be they banks, warehouses, residential flats, hotels, or churches, and which have no interest of their own apart from their easy flow of line.

But dwelling with especial emphasis, as I am doing, upon the decorative side of sculpture, yet I do not wish it to be assumed that all sculpture must necessarily be of that character alone; and, though feeling strongly the importance of looking at my art from this point of view, I still do not wish to ignore the existence of what is now called sculpture proper. "Freistehende," free-standing, as the Germans call it. But I think the line is a very fine one that can be drawn between these two kinds, and it is difficult to formulate an absolute definition, to include the one and exclude the other.

It would, for instance, be a matter of difficulty to decide—nor shall I attempt to take up your time by the too curious inquiry—whether the Chryselephantine statue of Jupiter was decoration to the temple of Olympia, or the Athena to the Parthenon; but of this we may be tolerably sure, viz., that fitness of place in these instances would have been the first question to be considered, quite as much and even more so as with works that are unquestionably deco-

rative, such as the pediment, metopes, and frieze of the outer walls. We may be sure at least of this, that they were not ordered of the artist merely to satisfy the desire of the public for some such statue, and then, as an after consideration, placed in the above-mentioned temples as the best place available.

If only to bring this truth more vividly home to us now, it would be worth spending a little time in turning our thoughts back to the ancient world. For whether the work may be classed as decorative or not, no important statue or group should ever be considered apart from the position it is destined to occupy: the modelling, scale of proportion, the treatment generally should be all adapted to its final position, and also, and this is equally important, to the light that it will then receive. That which applies with such force to the important temple statues of Greece applies equally so to the sculpture in cathedrals and churches; and any figure, even when completely free-standing, and meant to serve a definite religious purpose, as in Catholic churches, should be kept in harmony with the general design of the building, even though it cannot be said to be directly a part of its decoration. Speaking of the religious figures used freely for purposes of worship, an amusing incident lately occurred in Paris. Some sculptors there are said to have agitated against a certain manufacturer, who turns out a quantity of Virgins and Saints for this purpose, but who does not employ sculptors for the woik; the figures were described as wooden effigies with great staring dolls' eyes, dressed in gaudy robes of real material. The manufacturer maintained they were fairly good works of art, though some of them, he admitted, were atrocious! I think this illustrates very forcibly one class of work executed apart from decoration—the ridiculous side of it if you will, but, nevertheless, typical. There is another branch of the art, very different from that just described, but equally non-decorative This is work that depends upon its technique only for the merit that it may have: work generally small in character, such as statuettes of light and graceful fancy, of which the lovely Tanagra terra-cottas may be cited as good examples, which can be turned lovingly about, between finger and thumb, and the varying play of light enjoyed on their finely modelled surfaces. But this is a class of work that appeals really to the artist himself, rather than to the general public, for to understand and fully to enjoy the technique, more knowledge is required than it is possible for the general public to possess; and no excellence of workmanship alone will ever make a popular art.

But this delightful class of work need not detain us here, for beautiful as it is, it cannot seriously be considered as representative of the art of sculpture. "C'est magnifique," perhaps, "mais ce n'est pas la guerre." Moreover, this aspect of art has dangerous pitfalls all round it, and the articles produced may easily become mere *bric-a-brac*, and serve only to "count for garniture and household stuff," as Browning puts it.

I am confirmed in the higher view that I am taking of the decorative side of the art, and justified in looking at it thus seriously, by Professor Ruskin, who says, (in his "Aratra Pentelici,") that "the energy of growth in any people may be almost directly measured by their passion for imitative art, namely, for sculpture or for the drama." With this idea before him, he speaks of the decoration of a building—the Duomo of Pisa—as containing "the germ of a school of sculpture, which was to maintain, through a subsequent period of 400 years, the greatest power yet reached by the art of the world in description of form and expression of thought."

With such authority before me, I may be allowed to claim the utmost importance for decorative sculpture; and it is this view of the applied art that I wish to keep before you, and about which I should like to say a few more words, before submitting some examples from works of the past.

To deserve this measure of importance, decorative sculpture should first be in touch with the nation's demands, that the people may find illustrated on the walls of, and within their public buildings, in a language that all can read the stirring events of their time, the glorious deeds of their heroes, the history or legends associated with the growth of their cities, and thus that thoughts and sentiments may be roused within them at the sight of these buildings, in accordance with the object for which the building is erected, be it a hall of justice, a municipal building, houses of parliament, or a cathedral.

This is not a question for the sculptor alone; indeed, he can do little until the demand is made by the nation; and, no more than the architect can he produce the work if not commissioned. But the whole nation must be with him, first, in feeling the need for such true decoration, thus creating the de-

mand for it, and then by affording a healthy stimulus to the artist by wise appreciation.

It is significant that Goethe, in his appeal to German sculptors, where he is at pains to suggest subjects for their skill, assumes, as a matter of course, that they must be such as would appeal to the nation as a whole. Writing in 1817, the chief subject in his mind is necessarily war and its consequences, the victor and the vanquished, and he alludes to the great difficulty the modern sculptor has, over his ancient brethren in Greece, in the matter of costume. This no doubt is true, but it is a difficulty that can be overcome. Happily for us, there are other and more important subjects than war to interest and rouse us now, and I only take Goethe's instance to show the guiding principle underlying his choice of subject to enforce the truth of it home to us; for, simple as it is, it is yet wholly forgotten by the public at large, and sculpture can not be said to be a means of national expression at all in this country, with the one exception—through portraiture. The English people do like to have statues and busts of their great men; but this means of expression Goethe does not even allude to, and neither do I consider it to be one; it more often takes its place with other dismal funeral obsequies that are arranged on the death of an important personage, and is the easy means of unloading our minds of duties to the memory of the departed. Certainly it is oftener this, than an interpretation into stone of the virtues that may have distinguished him, or the good deeds done by him in some noble cause. The individuality of a man is, I admit, worth portraying, but even this is not achieved in the colossal isolated figures of which we are so fond; the very necessities of the case, the size of the statue required, and its position, prevent the sculptor from giving prominence to the individuality of a man, that could be given if placed in a building, or in a niche nearer the eye. But even the individuality of a man is not the most important fact to accentuate in a memorial, for this bears the same relation to the bigger forms of sculpture that biography bears to history; at the best it belongs to the smaller rather than to the larger assortment of facts. The Parthenon pediments—one illustrating, by a mythological idea, the importance of Athens as an inland rather than a seaboard city, and the other, the birth of its patron goddess; or, again, the tomb of Pope Julius II., by Michael Angelo, with its attendant figure of Moses—have a deeper significance in them than would have been apparent if Pericles and his counsellors had been depicted on the former, and the Pope and his cardinals on the latter.

But, although this may be the higher view of art, it would yet be a great step gained if we could possibly bring this national craving for the effigies of our great men, which, undoubtedly is laudable enough in itself, within the fold of decoration; and, by linking it to architecture, to give the figures meaning where they now have so little, detached and isolated as they at present stand.

No doubt the chief obstacle in the way would be, the great desire that people have to give sufficient importance to this class of work; the only form of sculpture, as I said before, that seems to have a permanent hold on the nation. As important, I suppose it would not be, if incorporated in some scheme of decoration, but it would be receiving only similar treatment to a picture-portrait, which is rarely placed on an easel in the centre of a room, but within a frame and hung on the walls. Some of this importance therefore might be sacrificed to the general fitness of things, and the æsthetic perception of what is really the most beautiful. The question of modern costume is one that, I think, should alone condemn our custom of placing huge portrait statues in our squares and open spaces. It is impossible to make a standing figure so dressed, interesting from all points of view, the back must be shapeless, even if the front is tolerable; a back view of a frock coat is a terrible object, especially when placed on the top of trousered legs. Ridicule is cast upon the unfortunate sculptor, when really the blame should rest on the people for ordering these huge effigies, and placing them where they stand. An equestrian statue is a very different matter, for the lines of a fine horse can be enjoyed at any angle, even if the rider, on account of his costume, should not be so interesting in himself, though in this particular he is not at such a disadvantage as his standing *confrère*, for the sharper lines of his position allow more play for folds, and for the costume generally to express the form beneath. We cannot expect to find as picturesque a hero as a Colleoni, but Marochetti's Cœur-de-Lion and Foley's Outram show us how isolated works of this character can be placed, and can be enjoyed quite apart from their surroundings, though Marochetti's figure certainly owes something of the happy effect produced to the fine background afforded by the Houses of Parliament; even as the statue of James II. by Grinling Gibbons does

to its position in the small square behind Whitehall. No doubt in all matters of reform, it is well in the first place to find out and acknowledge the ruling tendency of a nation's characteristics, and certainly ours in reference to sculpture is to give importance to Iconic forms over that of others. Thus, what I wish is, to take advantage of this tendency, and so erect our memorials that they may not only do honour to our heroes, but also be monuments in harmony with our fine public buildings; and let the buildings of the future themselves be planned with a view to them.

I may be allowed to point out that the outer niches of St. Paul's Cathedral are still empty, and it would not be the first time in our history that niches of our important cathedrals have been filled with kings and statesmen—civil heroes as well as church dignitaries. Take, for instance, Wells Cathedral, where are placed kings, knights and ladies, amongst the various bishops and other ecclesiastics; a sign, says Lübke, of "our early political consciousness and historical feeling." It would thus be in harmony with our own traditions if we dedicated these niches in St. Paul's to men who have left their mark on their age, and whose memory the age is desirous of preserving.

It would be pardonable in me, perhaps, if I looked a little ahead to see, in the now rapidly developing recognition of the worth of women in public affairs, another source of difficulty to the future sculptors, if their only chance for distinction lies, as it does now, in portrait statues in isolated positions in the open; for women will demand statues too; and difficult as it now is to make a male standing statue in modern costume suggestive of the figure beneath the garb, still greater will the difficulty become, when dealing with the fashionable dress of the other sex.

Let us, for all reasons then, be prepared for the erection of the coming memorials, by having homes made for them in buildings that are now being constructed, so that architect and sculptor may combine together and work out, each in their several ways, one common idea. To do this would be to return to our best traditions; it would emphasise the object of a building, and by accentuating the past deeds of great men in the scene of their labours, serve as a stimulus to coming generations.

With this simple principle in our minds, we shall be better able to understand how it is that the sculpture of the end of the last century, and the beginning of this, has so little of permanent value or interest to us, although the sculptors were, individually, often men of great ability; one or two, indeed, such as Roubiliac, of exceptional ability. One feels that the works of men like Bacon, Banks, Wilson, Gibson, and others is misplaced, or, rather, as if they were not intended for any particular place at all, but were executed for a museum, and for any odd corner where there was room. They do not touch us as they should, in spite of, as in those by Roubiliac, their great merit in execution. But not only are they not decorative in treatment, they are not representative of the leading thoughts of that age. I suppose the two leading ideas of that time were the establishment of our Colonies and the abolition of slavery. Yet neither of these great subjects inspired our sculptors then; at least, I can think of no important work that would typify them. When not engaged upon portrait statues, their skill was exercised in creating a Venus, a Diana, or a Cupid, which, at the most, could only rank as conventional classical imitations, not especially beautiful in themselves, and possessing for a future age none of that archæological interest that work, true to the thoughts and aspirations of its own time, must always have.

The chief exponent of this conventional art was John Gibson: to me there is a special sadness in looking back on his life and works. We are conscious now of the weakness of his work; but, even in my student days, most art lovers that I came across esteemed him as the finest sculptor of the day. It is not that fashion has shifted from classical standards to the freer development of the Renaissance—lovers of art will always love the best Greek sculpture—but it is the want of aim in his work, and their isolation from the thoughts of the time, that has brought this neglect. There is a warning note to sculptors in the words of his will, by which he bequeathed his casts to the nation:—"Yes, I do feel," he wrote, "that the collection of my models, seen together, would be of use to the young sculptors as to style." Now, not a soul but the very curious goes near them; and the works represent a splendid gallery of an art that is dead, because created apart and away from the needs of the time and the sympathies of the nation.

Flaxman's work was a glorious exception to this conventional art, and redeems this period from the wholesale condemnation that would otherwise be justly meted out to it. His reliefs are especially decorative, and when placed effectively, as I have seen them, they have

great power in accentuating the purpose of a building. Those that I refer to are panels from the Lord's Prayer series, and are let into the wall at the east end of a church, alone occupying the space, where they serve as true sermons in stone, without need of comment or words of any kind. Such I maintain to be instances of true religious decorative art. The inevitable result of detaching sculpture from architecture, and looking upon the art as independent of other arts, and capable of stirring sentiment alone and unattached, is this harping back on the old masters, and following in grooves dug out by them, working, that is to say, according to theories, rather than up to required needs.

Theories must always be cramping and dangerous if meant as a guide to future production. In sculpture it has proved itself to be especially so, because the art has been such a happy hunting ground for the critic and conoisseur. Theories are only interesting as gathering up and focussing what has been done, but not at all in deciding upon the form future work shall take. Of all theories, that based on the search for beauty is perhaps the most destructive of all original talent, and yet it is the one most frequently set up. Even Goethe, with his width of view and knowledge of the many sidedness of life, when commenting on Lessing's Laocoon, says, "The former (that is sculpture) had to confine itself within the limits of the beautiful," and again, "Sculpture labours for external sense, which is satisfied only by means of the beautiful." An artist, it seems to me, who is seeking for beauty, is as a man seeking for happiness, as the one aim in life; a desirable end to attain, but never attained by directly planning or searching for it. And it is the same with the attainment of beauty in sculpture; the end is only reached by having some more definite and tangible object in view, while the mere search for beauty only leads to imitation and trite conventionality. But let the immediate purpose of our work be the desire simply to tell a story and adapt it to the place that the work is to fill; then, in this happy filling up of space, the element of beauty will possibly be there without our striving especially for it; at any rate the work will be stamped with our own individuality, and that is an element always of interest.

Not only is it pernicious to the originality of the worker himself to be perpetually seeking only for the beautiful, but it deprives the work of an element, the value of which, it is true, is more appreciated by future races than at the time of execution. I refer to what I have already alluded to as the archæological side of art. How much have we not learnt of previous inhabitants of the world simply by the knowledge gleaned from their decorative sculpture! Besides well-known instances, such as the Egyptian reliefs, which give us the whole range of the nation's pursuits, take the case of the early and little-known race of the Hittites. What is known of their previous history and the knowledge of their far spreading dominion have been derived chiefly from the study of their sculptural reliefs. The presence of the mural crown and the double-headed eagle, in association with a certain ever-recurring decorative pattern, and the top-heeled boot, the high peaked turban, the short high girded sword, &c., these and other features all point, when found on slabs scattered over Asia Minor and elsewhere, to the presence of that early race. Again, much remains yet to learn concerning the Mexicans, when the curious hieroglyphics of their huge monoliths have been deciphered.

It is certain that this interest at least will be wanting to future antiquaries, if it is found that our works refer to a mythology foreign to our country, to heroes and gods not believed in by our race, and merely copied because they were nude. "What's Hecuba to him, or he to Hecuba," may well then be their cry. If we cannot invest our works with any lofty ideas, we can at least be true to the conditions of the time; and this we should much more readily be, if sculpture were the result of a demand from the public instead of what it so often is—the outcome of a chance action seen by the sculptor in a model in his studio, to which work he afterwards appends some learned Greek name.

While speaking of the danger of disconnecting sculpture from architecture, I should like to refer to two tendencies of the present day. One affects the art itself, and is, it appears to me, as pernicious to its free development, as the old-fashioned desire to produce only something beautiful, and that is the influence upon sculpture of the sister art of painting, which necessarily follows from the importance given to the yearly exhibitions, especially at the Royal Academy, in which the preponderence of painters to sculptors is as nine to one. Truthfully modelled surfaces and the literal rendering of nature naturally have more weight with a painter than with a sculptor, for, in painting, imitation of nature cannot be carried to too great an excess, and the

most thoroughly realistic work will still bear the impress of art on its canvas; but it is not so with sculpture, for a plaster cast from life will give the exact imitation without any art at all. The result of this painter-influence leads often to the neglect of design, composition, and all thought of suitability to any given place. The other evil to which sculpture is always liable, if disconnected with architecture, is to become the property of the few, instead of belonging to the nation as a whole.

In treating of the art from a decorative point of view, I have purposely kept my mind on the architectural side of sculpture, as the most important form of decoration, but I would wish it understood that I apply the term decorative sculpture to the covering of any surface that needs decoration, be it what it may, from the walls of palaces and municipal buildings, to fire-dogs, knockers, clocks, lamps, mantel-pieces, jewellery, &c. Of course these latter can never attain to the importance of architectural sculpture, for the reason above mentioned, that they must, for the most part, belong to the individual and not to the nation, but otherwise they merit as much thought and care as surfaces that are more pretentious. In this paper, I cannot do more than allude to them, but the mere mention of the above list shows the enormous field open to the sculptor, and the very wide range of his art as a decorative one. Neither do I think it necessary to draw any fine line between useful and purely ornamental articles. The æsthetic enjoyment of a fine knocker is, it is true, not in rapping with it, but the excellence of the artistic design and execution need not interfere with it as a useful article. I have often wondered, by-the-way, who buys those marvellously carved meerschaum pipes that one sees exposed in tobacconists' windows, and still more, who smokes them. This is one of those instances, I think, when we may exclaim with the poet that "Beauty unadorned is adorn'd the most." I must confess I can give no reason, save as Shylock puts it, "a lodged hate and a certain loathing" I have to the "adorned" article in question.

The difficulty that arises with regard to making jewellery really artistic and worth the sculptor's attention, is caused mainly by the fiend fashion; for it is impossible to justify fine work on an article that is decreed to be out of date a few months after it is made. The round brooch has to give way to the long, the broad bracelet to the fine and thin, quite independent of the workmanship and beauty that one or the other may possess. Yet great painters and sculptors in the past learnt their craft, and gained most of their valuable experience, in the goldsmiths' workshops; and our artists might do so again, if this paralysing influence were once removed.

I will now place before you some illustrations of the subject I have dwelt upon, begging you to remember that, as I have not put myself forward as one stating any new thing, neither must you expect to find amongst the lantern slides many that are not familiar to you. My object in showing them is that we may look upon our old friends in their right light, and class them under their right name—as decorative sculpture—thus in imagination bringing them out of the museums, and placing them back in the positions they formerly occupied on buildings, or in some way intimately associated with architecture.

Slide 1 and the following one are taken from part of a panel cut on the walls of the king's palace at Nineveh, and they require no explanation from me for introducing them as works of high-class decorative order. These alabaster reliefs decorated the inside of the apartments, and in this fact lies the explanation of the treatment of the relief; for the desired effect is attained with the least disturbance to the general evenness of the wall; there are no strong contrasts of light and shade (for no parts project much over others) as would have been permissible if the works had been intended for out of doors, and the spectator could have stood some way back to enjoy them.

It cannot be too strongly insisted upon that all treatment of relief is but a means to render nature nature-like under given conditions; the resemblance to nature being always the ultimate test of the work. So this flat relief was not intended to look flat, but the depth was chosen by the sculptor, as the condition enforced upon him by the circumstances, his chief aim being to render, as truly as he could, these battle and hunting scenes so dear to the Assyrians.

One of the interesting features of Assyrian sculpture is the wonderful facility with which the sculptors portrayed animals: lions, buffaloes, wild horses, mules, gazelles, and stags: though lions are the true heroes of Assyrian art. These animals are drawn with a vigour and naturalness that have never been surpassed, and the bold, even realistic manner in which they are conceived, compares favourably with

the best work of any time. To us the odd thing is that, when dealing with man, their sculpture is so vastly inferior; a constrained conventionality is always apparent, in strong contrast to these carefully-studied animals. This peculiarity has been explained by reference to the political despotism under which the people lived, which made it imperative to the sculptor to forego the study of the individual for fear of interfering with the importance of the king. Thus, curbed in the representation of man, the artistic taste of the people—due, it should be stated, to Babylonian influence—found perfect expression in another direction.

Slide 3. This figure, and the three below from the Parthenon, formed part of the eastern pediment of that building. The figure of Theseus, or, as it is now thought to be, the Mountain God, symbolising Olympus, was placed at the extreme end, and is thus the least important of the whole series in the pediment.

It is a wonderful triumph for decorative art that this figure, destined for comparatively an insignificant position, should hold, as it does, undisputed pre-eminence amongst the nude figures that have come down to us, even as the accompanying "Fates" hold sway amongst draped figures. The difference of scale is, of course, purely accidental.

With the Greeks, one sees that the human figure, unlike Assyrian art, was paramount; but tradition nevertheless was responsible for the evident uniformity of type that is aimed at. Individuality, as we understand the word, found no place in Grecian art; the faces of their deities were handed on through centuries, improved and made more human with each succeeding age, but they can be traced back to the scraped wooden images of the 7th and 6th centuries B.C. These gods were local, and were as present to the Greeks, as the Madonna and saints were to the people living in the 13th century of our era.

The subject of the whole pediment, of which these figures formed part, was the "Birth of Athena from the head of Zeus," a favourite subject of Athenian art.

Slide 4. This illustration is from perhaps the finest metope of the same building, and will be equally familiar to you all. Here, again, a dominant idea pervades the whole series, that of an allegorical representation of the earliest conflict between civilisation and brute barbarism, symbolised by the contest between the Lapithæe and the Centaurs. This panel forms an admirable answer to the statement sometimes made, that the Greeks did not depict strong action: one of a crop of errors that has grown out of an imitation of the antique, without its life and traditions.

Slide 5. This and the following I have selected from the famous Panathenaic frieze, to illustrate the happy way in which a realistic subject may be treated from a decorative point of view, and with due regard to the peculiar position of the frieze and the reflected light, upon which it was solely dependent for its effect. The subject is the "Delivery of the Peplos," a robe made by certain Athenian maidens, and at stated times placed on the old statue of Athena Polias in the Erectheum. In this procession all classes of the Athenian people took part, headed by their magistrates and other leaders.

Slide 6. It is interesting to note the difference made between the conception of gods and men. Here we have Hermes, Poseidon, Demeter, and Hephaistos, their greater size (allowed for by their sitting posture) and the absence of marked costume, alone apparently distinguishing them from the riders. The story is thus made manifest, but the whole brought together by treatment; and we are enabled to see in the metopes an allegorical representation of a myth, and in this frieze a realistic rendering of a historic fact, both treated as to be part of the decoration of the same building.

We have copied the relief, or the same kind of relief, on two of our buildings—the Athenæum Club, and the gate at Hyde-park-corner, leading into the park—quite ignoring the conditions that compelled the Greeks to choose this flat treatment. Placed high and exposed to the full light of day, as they are with us, there was absolutely no necessity for this kind of relief, and the result is a mere piece of tracery.

Slide 7. I am introducing this and the following panels to show the peculiar archæological interest that sometimes attaches to decorative sculpture. They are Indian works, but their style of execution, so thoroughly different from ordinary Indian work, show, in a marked degree, Grecian influence, the inspiring source of which dates back to the Greek invasion of India, that we know took place under Alexander the Great. The art of India is of much more recent date than was once supposed, and the first knowledge we have of Indian sculpture is after this Alexandrian invasion—about 325 B.C. This one is taken from a monument at Gaudara, in the Punjab, executed about the first century of our era, representing the death

of Buddha. The scene is depicted between two pilasters with Corinthian capitals, so especially Greek is the character; it is for this reason I am introducing it to you. When we think of the abnormal rather than the normal characteristics of Indian sculpture as a rule, and its delineation of the human figure as a body with seven arms, three heads, &c., the difference between it and these panels will be clearly marked. The small panel above is worthy of notice for the lively little Cupid at the right hand corner, which is characteristic, we should have thought, by its *abandon*, rather of the Renaissance than Greek decoration.

Slide 8. This illustration also shows the Græco-Roman style of ornament; the garlands and wreaths, resembling those on the entablatures of the Temple of Vesta, in Tivoli, which was erected B.C. 70.

Slide 9. The next representation shows some walls with battlements, and a doorway with jambs, such as were used in Etruscan doors (B.C. 400 or 500). This story is thoroughly Indian, depicting some legend of Buddha.

Slide 10. From a historical point of view, it would be ridiculous to bring this work before you, following so immediately on the last, thus jumping from the 1st century to the 13th. But I am merely introducing a few isolated examples of fine periods of art, to show how decorative sculpture can be applied to noble uses, and that it was as decoration that the chief sculpture of the past had been employed. This panel is from Rheims Cathedral, and illustrates, as well as any I know, the charm of the Gothic order. There is something especially beautiful in the slender and delicate proportions of the figure. Looking at this illustration, we can understand the writer when he says that, in the 13th century art, more of the good than the evil of the world was depicted, more of its beauty than its ugliness. We see now, too, the tendency in Gothic art to the vertical, instead of the horizontal lines, characteristic of Greek work.

Slidn 11. This figure is from the Chapter-house of Westminster, and represents the Annunciation. It has the same slender proportions as the preceding ones. Gothic sculpture is more dependent upon its surrounding architecture than is the Greek, and its effect is marred to a greater degree when seen away from it, as is the case here, where the figure has been photographed in a museum.

Slide 12. This lovely illustration is from a glazed terra-cotta by Luca della Robbia. I have not been able definitely to locate it, but it is probably from some church in Florence. The treatment is charmingly tender and natural, and the simplicity of the composition enhances its beauty. It is interesting to see in this frequent adoption of the subject of the Madonna and Child, the chivalry of the mediæval world asserting itself; "the chivalric, mystic love of the Middle Ages."

I wish especially to refer to this work, as typical of Luca della Robbia, for I suppose no sculptor has more effectively rendered this beautiful Madonna worship of that age. As Lübke puts it, "he appears unwearied and inexhaustible in the delineation of a calm nature, brightened by loveliness of expression."

It is very suggestive to compare the Madonna of the 15th century with the Greek Venus, both typifying, as they do, the national conception of divine love; one is youthful, in the full perfection of form, with the calm contentment of expression of one who is perfect and beautiful in herself, and for herself alone; the other suggests maturity, coupled with a fineness, rather than a fulness of form, as seen also in Donatello's Madonnas, but the self-satisfied look of complacency of the Greek goddess is replaced by the sweet sense of motherhood, with its entire self-abnegation and self-effacement; for the woman's thought is centred in her child.

Slide 13. This illustration is from one of the twelve spandrels, also by the same sculptor, that are placed to each arch of the Foundling Hospital in Florence, and that form such beautiful decoration to the building. Each little figure is enveloped in swaddling clothes, every one differing from the other in position and expression.

14. These decorative panels are well known, and need no comment of mine to lend appreciation to them. Jean Goujon is one of the first sculptors, whose name would occur to us when thinking of decorative sculpture. We see here how he adapted the figure for decorative purposes to fill up his spaces; and the masterly treatment and skilful arrangement of light and shade, afforded by the contrast of the nude and drapery, give us a sense of pleasure whenever we look at them. The originals, designed for the Fontaine des Innocents, are now in the Louvre, but casts of them may be seen at the South Kensington Museum.

Slide 15. This illustration carries our thoughts on to modern times; for Michael Angelo was essentially a modern sculptor, who attempted something more than to embody the purely emotional character of the Middle Ages. The

struggle of the time—life, with its inward experiences and sorrows and outward unrest—are well exemplified in the intensity of expression and violence of the position of all his figures. He was not one who himself lived outside the storm and stress, but took an active part, as we know, in the political life of the times.

There is scarcely one of his works that might not be considered decorative, with the exception of the "David," that owed its existence, as we know, to an awkwardly shaped block of marble.

This figure called "Evening" formed part of the tomb of Lorenzo de Medici. It is a splendid decorative work, though it is difficult to understand it by the title given; it is rather, like the figure of Lorenzo himself, an emanation of the great sculptor's brain, independent of particular subject, but which, with its companion figure of "Morning," appeals to us by its grandeur and dignity, as embodying the spirit of restless activity and deep contemplation, so essentially characteristic of the sculptor. We see the wide scope that there is for decoration dependent only on the genius of the artist, and the consequent uselessness of rules for its guidance, when we note the works of sculptors such as Michael Angelo and Luca della Robbia. The art of the latter is based upon realism, as seen in the panel from the Foundling Hospital in Florence that I showed before, where the babies are all wrapped in swaddling clothes, as could be seen in any house at that day, while here we have an artist's powerful ideal conception untrammelled by any thought of costume.

Slide 16. From sculpture of our own time, I may refer to that of Alfred Stevens, whose work is amongst the finest we have, and is again almost entirely decorative. This plate represents one of the side groups of his masterpiece, the Wellington monument in St. Paul's. To those who have thoroughly realised that sculpture should, for the most part, be connected with architecture, his works must appeal with great force. The pity is that, placed where this fine group is, against a window, the effect of it is quite lost; indeed, to enjoy it and the whole monument, we must go to the South Kensington Museum, the home of the decorative arts, where successful attempts are now made to show the art in its own architectural surroundings, as far as possible. Seen from the other side, this group before us, "Truth taking the tongue out of Lying," is not so pleasing, for the sight of a wrenched tongue is unpleasant, and the close imitation n stone of a poetic thought rather revolting.

On the other side of the monument, the group "Valour and Cowardice" is a more pleasing subject, and simpler in thought, whilst equally fine in execution.

Not only was it in the higher fields of decorative sculpture that Alfred Stevens so well succeeded, but in the minor forms, such as for mantels, fireplaces, grates, &c. He was a perfect master in the management of ornament; nothing in sculpture was too great or too little for him, but all he did was directed to definite ends.

Slide 17. There are two or three more illustrations I should like to show you before I finish, and these are of French work. The first is M. Dubois' group of "Charity," that occupies one of the angles of the monument to General Lamoricière. It is important for our purpose, because it shows the possibility of going to real life for our subjects for decorative art. This is not merely an abstract idea of Charity, that might have been used in Græco-Roman times, or even at the Renaissance, but we see that the figure, by her face and dress, is taken from a woman of this time and the nation, to which the work belongs; and thus would speak as directly to the most unlearned now as an Aphrodite or Minerva did to the ancient Greeks. It will be seen that the drapery, as well as the type, is of to-day, as the stuff used is not the thin, clinging material worn by the Greeks in their hot climate, but a thick, woollen texture, suitable to our more northern latitude.

Slide 18. This figure is from the opposite of the same monument, and represents Know-Knowledge or Wisdom. I show it because it indicates again a departure from ancient ways, as it is a successful attempt to depict age. There are as few important works of the ancients representing age as there are those representing children. They restricted their art to the ripeness of mankind or the fullness of youth. With us the whole gamut of age is free for portrayal, even as our views of life, its purposes and aims, are wider; and we feel there is as much dignity to be derived from the one as abstract beauty from the other.

Slide 19. The last illustration I shall show you is by M. Dalou, a sculptor well known in this country, for the many excellent works he executed when here, and the impetus he gave to the art generally. This is from a large bronze panel, placed in the Chamber of Deputies in Paris, and represents the Declaration at Versailles in 1789 by the Third Estate (afterwards the National Assembly) that henceforth

it, and not the king, would represent the nation:—"Go, Monsieur," says Mirabeau to the deputy of the king, "tell those who sent you that we are here by the will of the people, and that nothing but the force of bayonets shall send us hence." Truly a stirring scene and affording a difficult problem to solve by the decorative artist. But what better decoration to a Chamber of Deputies could there be than such a subject!

To sum up the few ideas I have ventured to express: I maintain first of all that sculpture must in the main be decorative, allied chiefly to architecture, and speaking to us from its walls.

When thus linked with architecture I would have it free within these limits, to develop the individuality of the artist, and the characteristics of the time; I should wish it to be as true to latter day life as possible, and thus be in touch with the age. If the artist has imagination, and can see through the surface of life into the hidden mystery of things, let him by all means represent it; if not, let him portray life as he sees it, and we will hope that the necessities of the conditions under which he works, that is, his architectural surroundings, will tone down any too strongly developed tendency to realism. Why, even our foe, the frock-coated gentleman, might not pose amiss, when twisted into a miserere or a gargoyle!

Such are the few thoughts that seem to me to be important to us sculptors at the present day, and their importance to us means importance to the nation at large; for, if art is to be of any use at all, it must be in touch with the nation. As Mr. Frederic Harrison has lately said, when speaking of the great Gothic period of art, and the memorials it has left to us, "These vast temples are the creation of generations of men, and the embodiment of entire epochs; and he who would know the Middle Ages should study in detail every carved figure, every painted window, each canopy, each relief, each portal in Amiens or Chartres, Rheims, Bourges, Lincoln, or Salisbury, and he will find revealed to him more than he can read in a thousand books."

DISCUSSION.

Mr. HUGH STANNUS said, knowing Mr. Mullins's admirable little Primer on sculpture, he had expected to hear a very interesting and instructive paper, and he had not been disappointed. What Mr. Mullins had been pleading for throughout seemed to be the necessity that sculpture should have that connection with the monumental forms of architecture which it had in the beginning, and from which it was only divorced by passing fashion. There were two other points which struck him as being important in the paper, one was where Mr. Mullins pleaded that all sculpture should tell a story, that it should not be merely the running up and down the scale of forms, but that there should be Storiation as an element, not merely æsthetic decoration. He believed all would agree in the view—that whatever in decorative work appealed not only to the sense of beauty but to the intelligence of man, and the associations of the past stored in his memory, would be thereby very much more worthy of attention than mere egg-and-tongue or Roman scroll repetition. Then, secondly, there was a point of still greater importance, the contemporaneousness of sculpture. Mr. Ruskin had said, in words which were so fine that he hesitated to spoil them by quotation, that every artist who had powers confided to him by a beneficent Providence, was responsible for the use of the talent to his own day and generation, to represent the facts of his own day in the costume of his own day—not to seek the facts in the beginning of old forgotten mythologies or in the toga or chlamys of classical times—but that he should seek the events that were worth remembering of his own day, the deeds of heroism that were done every week in London, in England, or under British rule, and should clothe the figures in the costume of the time. This was a strong point made by Mr. Mullins, and he thought many would sympathise with him in it. He had referred to the difficulty of dealing with modern costume, and no doubt it was a difficulty. No one contended that the back view of a dress-coat was interesting, but inasmuch as the interesting part of every friend was his face and not his back view, so the sculptor would be justified in treating the subject as was shown in the noble statues against the old cathedrals, in which the figures showed their front view, while the back view was hidden by the building against which they stood. Then he had pleaded for utilisation of the niches of St. Paul's, and there are many other niches which are crying out for occupants. Unfortunately, when committees colleet subscriptions for the memorial of some great man, they are not content that the statue should be put up to form one among a number of others; but they always want a special site given to it in some open space. When the time came that all the open spaces are full and can accommodate no more, probably they would think of these open spaces in buildings, and he felt quite sure it would be a very proper use for them. The paper throughout was very full of interest and instruction, and he begged to thank Mr. Mullins, personally, for the pleasure he had given.

Mr. LEWIS DAY said he also had listened to the paper with great interest, and in the main agreed heartily with the author, but not when he spoke of the harm done by theories, and by seeking after the

beautiful; there he must protest: he entirely dissented from that view. Theories might easily be pushed too far, more especially if they were adopted at second-hand; but without theories or something very like them—call them convictions if you liked—he did not see how an artist could complete himself. He was old-fashioned enough to believe in the beautiful —as he thought, after all, the author himself did, for when it came to illustrating his paper, the examples shown were all beautiful; they went to show that the sculptor, Assyrian, Greek, or Italian; Jean Goujon Alfred Stevens, modern Frenchman, or whoever he might be, not only sought after the beautiful, but found it. Mr. Mullins had, it was true, guarded himself, in one instance, by speaking of "only the beautiful," but no one in his senses contended that an artist should seek nothing more than beauty in his work. If he were a man as well as a sculptor he would have something to say; and, inasmuch as he was an artist, he would put that into beautiful shape. An artist must seek beauty—a sculptor must seek beauty of form; from sculpture which was not beautiful the speaker prayed that we might be delivered.

Mr. REGINALD BLOMFIELD said there were one or two points he felt a little disposed to quarrel with. Mr. Mullins insisted that the sculptor should deal with what he called the leading ideas of time, but he thought that would be rather difficult to carry out, because no one was very clear as to what the leading ideas of the time were; some thought it was making money, and others thought other things, but it would be difficult to lay down any general principle. It seemed to him much wiser to leave it to the man himself. The main thing he had to do was to express what was in him. If a man had anything to say, it did not follow he could say it, but if he tried to say it, and said it with any degree of success, his work was sure to be interesting, and if he did it well, in beautiful form or colour, it would take a high place as a work of art. Again, this point of contemporaneousness, as it had been called, seemed a little awkward too. He really did not see why a sculptor should be limited to our exceedingly hideous dress if he chose to work in some other way. That seemed to hang on to the idea raised by Mr. Mullins as to historical sculpture. Mr. Mullins referred to the Hittites; he had an exceedingly hazy idea who the Hittites were, but when they flourished there certainly was no such thing as written history, no such thing as a penny paper. When the Assyrians produced their magnificent sculptures, no doubt it was very proper for them to represent the lions and lionesses slain by the king, but it was not the least necessary to do that now-a-days when the Prince of Wales went out hunting, because there were plenty of people to record it in the legitimate way in writing. He thought it was rather a failure as a rule both in sculpture and painting when an attempt was made to record current events. However, the subject of the paper was sculpture in relation to architecture, and it was undoubtedly a burning question of the day, in relation both to sculpture and architecture, how the two could work together, and what was the common ground on which they could meet. What struck him in London was the enormous quantity of sculpture about and its exceeding badness. In Shaftesbury-avenue there were a great quantity of houses, and he did not think there was a single piece of good sculpture in any of those new buildings, although there was a great quantity of it. There was one building which struck his eye very prominently, plastered all over with figures modelled in terra-cotta, turning themselves inside out, standing on their heads, eating their tails, and doing all sorts of things; but there was no meaning in it. It might be all very pretty, but, it seemed to him, that any intelligent person who took a chisel and hacked the face of the material, would get just as valuable an effect with regard to the architecture of the building as was accomplished with all those arabesques, or whatever they might be. He had seen the same thing in another important building, whose face was simply bespattered with this sort of rubbish, though, in the same building, there was some very beautiful work by a sculptor, as opposed merely to the ornamental carving. The work of that sculptor was very beautiful, and seemed to him to add much to the value of the building. He spoke as an architect, and did not see why architects should not resolutely set their faces against this stuff, and all merely conventional ornament; and, when they had the chance of having money spent on sculpture to concentrate their effort on one point, see that the workmen had something to say, and that the work was done by a competent man. He was afraid they did not know enough about each other. Architects did not know enough about sculpture and modelling—and consesequently, did not understand sufficiently the point of view from which the sculptor went to work. On the other hand, sculptors did not know enough about architecture in the best sense. There were of course brilliant exceptions. Alfred Stephens certainly showed immense genius in the Wellington monument, which was a great architectural work, and he did not think anyone else could have designed it; and their distinguished Chairman also had done great work in this way. If sculptors would occasionally give architects a hint, it would be much to their advantage; and sculptors, on the other hand, might perhaps learn a trifle or two from the architects.

Mr. W. S. FRITH thought everyone in the room would agree in the main with what had been put forward in the paper, and it was much to be hoped that the view expressed by Mr. Blomfield would prevail amongst architects. If it did, that would be certainly a very great step in the direction they were all desiring, the proper application of sculpture, and the proper use and display of it. On the side of sculpture, he feared that many of the evils complained of were largely due to the number of sections in which it was split up,

some of which were hardly supposed to belong to it at all. A little time ago anything really connected with architecture was scarcely looked upon as sculpture, and sculptors confined their energies to producing busts and memorial statues, most of them of a very bad order. If sculpture were looked upon a little more as being the art of using form as a means of expression, they would come to the point of which Mr. Blomfield spoke, in which architecture and sculpture really touched one another. He feared no prescription could be laid down as to the costume in which sculpture of this day or that day should be worked. Sculpture belonged to all time. The statues of the Greeks were as fresh now as they were in their days, but they were not in rigid adherence to the costume of the people.

Mr. HOWARD INCE said one or two points had especially struck him in the paper: one, where Mr. Mullins mentioned the fact that ancient, or mediæval, or Renaissance sculptors and painters were accustomed to study, and had all their early training in the goldsmiths' shops. That, he thought, accounted for the decorative quality of their work. They were thoroughly trained in decoration, and that was something which was not born to one; it required long and severe training; and, because those men had that training, they succeeded as they did. It was a great thing to have such a paper as this read; and he hoped it was only the beginning of a new era, in which decorative work would take a high place; and be recognised, if not as the chief, at any rate as a very high branch of the sculpture and art generally of the country.

Mr. MULLINS, in reply, said the differences of opinion which had been expressed were not many, but he could not soften down anything he had said. First, with regard to Mr. Day's remark about beauty. He hoped it would not be assumed that because he said beauty ought not be the chief force in the sculptor's mind, that therefore he was not to seek for beauty. There should be no one abstract idea of beauty. Anyone who had read Lessing's "Laocoon" would understand his allusion. He did not assume that each man had his own way of looking at beauty, but that his own standard of beauty should apply to everybody was what he objected to. It was necessary to have convictions, but one man's conviction would not be the conviction of another, and he should like that each man should represent his idea of beauty quite independently of the idea his neighbours might have of it, certainly not the one idea that he should go to a book or standard for, but that he should seek for it in his own character. Mr. Blomfield had referred to the difficulty of portraying leading ideas, and of course it was difficult, but the historian succeeded, and why not the sculptor. The sculptor should bring in the historian to help him, and he might arrive at the general bearing of the period. He did not mean merely the last twenty or ten years, but the sculptor could study the times, and attempt, if he had the opportunity, to portray what had happened in his own country. It was difficult to get an abstract view of particular events, but that was the great thing to aim at. It was said that it would be difficult to carry out these leading ideas, and that it would be better for the man to do what was in him; but he thought it was possible to do the two. He agreed in what had been said about architectural ornament. It was rather the corollary of the paper. All useless filling up of space, which had done so much damage to decoration, was objectionable, and he could not see why there should not be more meaning put into it. He could not help echoing the thought and words of Mr. Stannus as applicable to some of the work of the Chairman representing death, the poppy, and the doves. That was the sort of thing they ought to seek for in sculpture.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Mullins for his paper.

The vote of thanks was carried unanimously.

FOREIGN & COLONIAL SECTION.

Tuesday, April 5, 1892; Sir CHARLES TUPPER, Bart., G.C.M.G., C.B., in the chair. The paper read was "The Red and White Races in Manitoba and the North-West," by the Rev. JOHN MCLEAN, D.D

The paper and report of the discussion will be printed in the next number of the *Journal*.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 6th, 1892; Sir DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Chorlton, Thomas, 32, Brazenose-street, Manchester.
Hill, Lieut.-Colonel John, R.E., Poona, India.
Holzapfel, Albert C., 57, Fenchurch-street, E.C.
Lowenfeld, Henry, 31, Lowndes-square, S.W.
Ryder, Charles, Gledhow-hill, Leeds.

The following members were balloted for and duly elected members of the Society:—

Kirby, Frederick Hall, Union Club, Trafalgar square, W.C.
Meacham, Charles S., 62, Earl-street, Maidstone, Kent.

The paper read was—

THE FUTURE TRADE RELATIONS OF GREAT BRITAIN AND THE UNITED STATES.

By Robert S. McCormick.
Resident Commissioner for Great Britain from the Columbian Exposition.

Part I.—Historical.

In preparing the address which I am about to deliver, in response to the invitation with which you have honoured me, it has been my endeavour not to forget that I am a member of this Society, as well as the representative of the World's Columbian Exposition. I have read somewhere—I think in an article in *Lippincott's Magazine*—that "we (meaning Americans) are very critical of the foreigner, and we are very conceited about ourselves. In this we are not peculiar. Love of country walks hand-in-hand with prejudice. Where such does not exist the passion is apt to be wavering and wan. Nevertheless, it is well now and then to reverse the lens of criticism, shorten the focus, and turn it upon ourselves. No one can for a moment doubt, of course, that we are worth more than anybody else, but it is a healthy process for every kind of truth to be put occasionally upon the defensive." Not only is this true of Americans, but it is true of every nation on earth, and the process above recommended is equally as good for others as for Americans. It is also important that we do justice to others and not form our opinions of them upon limited knowledge, or select isolated actions as a foundation for our conception of their character.

Beginning with "No good can come out of Nazareth," and coming on down through the "Heathen of the Jews," "the barbarian of the Greeks," "Greek faith," "perfidous Albion," "rascally Dutch," "British greed," "a nation of shopkeepers," "Turkish horrors," "Russian barbarities," "Bulgarian atrocities," "German infidelity," "French morals," to Mark Tapley's "American Eagle," and "Despotism, anarchy, and Corruption in the United States of America," and the "Brand of Cain in the Great Republic," the last two named being the titles of rather recent articles in English magazines of good repute; prejudice, the child of ignorance, has thrown these upon a screen as the prominent if not the leading characteristics, negative or positive, of the place and nations to which they have respectively been applied. Pride, self-conceit, self-interest, oftentimes a false conception of self-interest, too often lead to a false judgment of men and things, and this is the "pride that leadeth to destruction." Do not think that I am going to read you a homily on the virtue of humility, or preach you a sermon on its converse, the sin of pride. I only wish in the beginning to ask you to hear what I have to say, with your judgment free so far as humanly possible, from the influence of tradition, which oft-times beclouds the facts of history, as well as for the time being at least, free from your own conception right or wrong, of the interests which it is your right and duty to uphold and protect in such manner and by such means as may seem best to you, according to others the same right and recognising for them the same duty.

The trade relations between the United States and Great Britain—the subject upon which, at the request of your secretary, I have undertaken to read a paper—cannot be properly understood unless we go back at least 200 years, and consider the events which gave birth to and fostered England's commercial supremacy throughout the world, and the great mechanical inventions which developed this supremacy to its splendid magnitude. If there were time, and this the proper occasion, it would be interesting to begin with that early prototype of England, Pheonicia, "the smallest and yet the richest nation of antiquity, whose ships and sailors were the finest in the ancient world," and follow westward the rising sun of commerce as its bright rays illumined and enriched in turn Carthage, Greece, and Rome, to its eclipse in the dismemberment of the Roman Empire; and then with its returning light in the Middle Ages witness the signing of the first Treaty of Commerce 796 A.D., between Charlemagne and Offa, king of Mercia, by which document the former granted his protection to English traders from that district: showing that you were already sowing the seed of future policy and future commercial supremacy; on through the upbuilding of Venice (upon a site as impossible for a city as that of Chicago was pronounced to be by a United States Government official), with salt and fish as her only articles of export, but made the great *entrepôt* of trade between the continent of Europe and the East, securing the exclusive right of selling the mineral salt of Hungary and Croatia—an effort at monopoly, then as now, being the order of the day—and becoming, like England later on, the great carrier of the world, employing a commercial fleet of 3,000 merchant vessels, of from 10 to 100 tons burden, and in addition 40 war ships, each carrying 100 men, a prototype, in minia-

ture indeed, of the England of to-day, of which you are so justly proud. Genoa and Milan also had their day, and then the Italian cities whose commercial wealth had brought them political independence, succumbed to internal dissensions, the discovery of the sea-route to India contributing to their fall. Were there time I would like to dwell upon the history of the Hanseatic League, with its "factories" or branches at Novgorod, Bergen, Bruges, and London. The last named was abolished after frequent attacks upon it by London mobs in 1597. "Our own merchants," says an English authority, "had become too strong to brook a foreign rival in their midst." "Its primary object was to afford mutual protection to the cities composing it against the Continental piracy that had infested the German and Baltic seas ever since the coming of the Northmen."

The work which it did for the improvement of mediæval society, the growth of industry, and the development of commerce, entitle it to more than a passing notice in the history of civilisation. Having played its part, it disappeared as the foundation-stone is buried beneath the classic pile which attracts and rivets our admiring gaze. In the same way rose and fell the Confederation of the Rhine and the Suabian Confederation. If we glance at a map of Europe in the Middle Ages, says an authority, "we shall find that by far the greatest centres of manufacture were in the north-western corner of the Continent—the portion now occupied by Belgium, part of Holland, and a small part of the North of France. Linen and woollen fabrics were chiefly made there. The eastern counties of England, especially Norfolk and its great centre Norwich, and the western counties of Wilts and Somerset, also made a good deal of woollen cloth. The main branch of manufacture in the south of Europe was that of silk, which was made in the north-east corner of Spain, in the district round about Barcelona; in France, round about the great centre of Lyons; but, more than anywhere else, in Italy, round Genoa, Milan, Venice, Florence, and Naples. The raw wool, for making cloths of all kinds, was sent to Flanders from two main sources—England and Spain; but English wool was superior to Spanish for fine cloths; and, moreover, in most cloths, Spanish wool required to be mingled with English before it could be worked up. England and Spain, then, provided the raw material, and Flanders did the manufacturing part of the woollen cloth trade. Wool, indeed, in the Middle Ages, was the basis of England's wealth, and paid for many of her wars."

In the 10th and 11th centuries, the Counts of Flanders were wise enough to promote actively the welfare of their subjects, and the growth of industry; and it was from this time that the country became famous throughout Europe for the weaving and fulling of cloth. Arras, Cassel, Tournai, Valenciennes, St. Omer, Rousselaere, Contrai, Yprès, Lille, Ghent, and Bruges all became famous and prosperous cities, the four last named leading the rest, and having each of them as many as 40,000 looms constantly at work, largely supplied with wool from England. The city of Ghent had, in 1400, 80,000 men capable of bearing arms, the weavers alone furnishing 20,000. Bruges, with its canal to the sea, was practically a port, until the canal was blocked up by Maximilian of Germany, in 1482, when Antwerp came to the fore, being a port of great importance, and coming in for a large share of the commerce with India, around the Cape, and later on with the New World, the discovery of which, with all that it signifies, we will celebrate at Chicago, in 1893. With its rich neighbours, Antwerp fell a prey to the persecutions of the Spaniards, being twice sacked by them, and London stepped into the proud position of the great emporium of the western world, and has held it now for about three centuries. And this brings us across the channel, and within the confines of the "tight little island," whose place to-day in the world of commerce, with its sun nearly at the meridian, should make her take rank with the "Seven Wonders," and in comparison dwarf to pigmies the giants of earlier days. "Although England is now such a commercial nation, she by no means occupied such a position in the Middle Ages. Her manufactures were far more outshone by those of Flanders and the Italian cities; her commerce was almost insignificant compared with that carried on by the mighty merchants of the Hansa, or by the enterprising traders of Genoa and Venice; nor did England begin to gain the greatest maritime and commercial position which she now holds till the reign of Elizabeth (1559-1603), shortly after the Reformation and the discovery of the New World, and of the new route to the West Indies. Trade and commerce had been probably more flourishing in England under the Romans, and it is interesting to note corn [or, as we would say in the United States, grain] was an im-

portant article of export, for in 359 [according to the historian Zosimus] 800 vessels were sent from Britain with corn to succour the Roman colonies on the Rhine, which had been plundered. But the history of commerce remains almost a blank until the days of Alfred, who encouraged trade by cultivating relations with foreign princes, sending embassies as far as India; and also, in 887, founded the English Navy. Athelstane, following in the footsteps of Alfred, encouraged foreign trade by issuing a decree that 'every merchant who fared thrice over the sea with a ship and cargo of his own should be worthy of thane right,' *i.e.*, should rank as a nobleman; and when we come to the reign of Ethelred II. (979-1016), we find mention of a law regulating the tolls on ships putting in at the harbour of Billingsgate, which was, even then, a fish-market; of trading vessels coming from Flanders, Normandy, and of German merchants, called the Emperor's men, who were allowed to trade in London. Finally, as the country became more settled, wool was exported in ever increasing quantities."

From this page in your history, over which we are now glancing, we see that England at this time stood in the same relation to Flanders as the United States held to England at the beginning of the present century, and for some years thereafter that relation still existing to a great extent. You were exporting raw material to Flanders, and taking back in in exchange therefore the product of Flemish looms. Though Henry I., in 1110, endeavoured to encourage domestic textile manufacturers, by establishing a colony of Flemish weavers in Ross and Pembrokeshire, it was some centuries before you could make into fine cloths the wool which your flocks yielded. During the "golden days of good Queen Bess, our competitors," says Gibbins, the author of that excellent short work, "History of Commerce in Europe," from which I have freely quoted as an English authority, "the Netherlands were severely crippled by the Spanish persecutions. But England did not benefit merely by the cessation of their competition; she received at the same time hundreds of Flemish immigrants, whose skill and capital greatly aided our home manufactures. Germany, also another competitor, was soon after utterly ruined and exhausted for a long period by the terrible Thirty Years' War [1619-1638], and with Germany and the Netherlands laid low, English manufacturers had little to fear. And at this very juncture the King of France, Louis XIV., did us an enormous service and his country an enormous loss, by driving out of his country the pick of his manufacturers and artisans—the Huguenots, or French Protestants, 50,000 of which came to England with a capital among them of £3,000,000. All the nations of the earth were kept warm with the wool from England. The victories of Crecy and Agincourt were very brilliant, but they certainly never could have been gained unless England had had the means of putting a strong army into the field, and the means of doing this was provided by wool."

In 1331, Edward III. invited John Kemp, of Flanders, and other weavers, dyers, and fullers to come over and settle in this country under his favour and protection, and then was the beginning of your manufacture and export of cloths, though it was a long time before the export of cloth became at all important. So, too, foreign merchants taught you to undertake foreign trade; foreign merchant fleets largely monopolising the carrying trade until early in the 16th century, the "Merchant Adventurers' Company" secured their charter in 1505.

It would be needless for me to recount the struggle in India, between the Portuguese, the French, the Dutch, and the English. I will only remind you that the Portuguese led the way, the Cape route having been discovered by Vasco de Gama four years after Columbus discovered America, though, as Sir George Birdwood tells us in his interesting Handbook to the British Indian Section at Paris, in 1878, Necho had accomplished this voyage with a Phœnician fleet twenty-one centuries before. It was nearly one hundred years afterwards, in 1582, that the first Englishman, Captain Stephens, sailed round the Cape to what is now your Indian Empire. It is interesting to mention here, to show the relative growth of your shipbuilding and commerce in three hundred years, that "in 1593 a Portuguese ship of 1,600 tons burden was captured, being the largest ship yet seen in England."

In the New World, the discovery of which we are now about to celebrate in Chicago, Spain had a complete monopoly until almost the end of the 15th century, the other European powers not seriously turning their attention in that direction.

From this it will be seen that other nations were the pioneers in discovery and commerce, although it was left for the Anglo-Saxon to develop and secure the wealth which soil, mine,

and forest would only yield to the talismanic combination of brain and brawn. Results have shown what race are the possessors of this combination, in the highest degree. Spain explored her new colonies in the west with only one object, the acquisition of gold and silver—with a minimum amount of labour. We must leave unopened the history of the period intervening between the decline of Spanish power, and the establishment of the English in the North American Continent, and the foundation of the Colonies which afterwards became the thirteen original States, only mentioning the fact that "here as in India England was almost the last to enter upon a colonial career." Toward the middle of the 17th century, England had taken rank as a manufacturing nation, and was exporting in considerable quantities manufactured articles, cloth mainly. During the Commonwealth also the sugar industry in the West Indies began to flourish and great fortunes were made out of it. But the carrying trade between the West Indies and America and England was still largely in the hands of the Dutch, and the English Government made an effort "to remedy this state of things in a manner which demanded special attention," says Gibbins, "by the passage of a law known as the Navigation Acts of 1651". These Acts declared that no merchandise, either of Asia, Africa, or America, except such as should be imported direct from its place of growth or manufacture in Europe should be imported into England, Ireland, or Scotland, or the English Colonies, except in English-built ships. The ships must, moreover, belong to English subjects, be managed by English commanders, and have at least three-fourths of the crew Englishmen; and these laws continued in force until the present century, 1825.

These Navigation Acts, as says the English authority from which I am freely quoting, were a bold declaration of what afterwards became England's avowed commercial policy; protection against foreign competition. In this connection, and following out the line which I laid down in my opening pages, I wish now to place before you briefly for your unprejudiced consideration, the aspect in which other nations have viewed England's commercial policy down through the 340 years which have elapsed since the Navigation Acts were passed, these Acts remaining in force, as said above, as late as 1825. It is necessary for me to do this, as many of your fellow-countrymen, if not fellow-members of this Society, have been harsh, not to say severe and unjust in their criticisms of customs laws passed at Washington—whether wisely or unwisely it is not for me to say—in the interest of American industries, as viewed by the majority in Congress voting for them. Some of your fellow countrymen, if not of your, I should say, our fellow-members, forget in these criticisms that at Westminster your law makers have ever stood ready to protect, nay, more, to advance by heavy subsidies, the interests of the commerce and industries of Great Britain, by legislative enactment. Listen then, with patience, to a little more history before I undertake to picture to you the future trade relations between Great Britain and the United States.

Sir Donald Mackenzie Wallace has told you in his "Russia" how England's commercial policy is viewed in that country, in the following words:—"Great Britain is at present in the position of a successful manufacturer who has outstripped his rivals and has awakened amongst them a considerable amount of jealousy and envy. To justify these feelings a peculiar economic theory had been invented. England, it is said, has become by her *politique d'exploitation*, the great blood-sucker of less advanced nations. Having no cause to fear competition, she advocates the insidious principles of free trade, and deluges foreign countries with her manufactures to such an extent that native industries are inevitably overwhelmed. In the pride of their hearts the manufacturers and merchants of Manchester and London may exclaim—using the quaint old words of the poet Waller:—

> "Gold, though the heaviest metal hither swims;
> Ours is the harvest where the Indians mow,
> We plough the deep and reap where others sow."

Thus all nations pay tribute to England, but this cannot last for ever. The fallacies of free trade have been detected and exposed, and the nations have found in the beneficent power of protection a means of escape from 'British thraldom.' So much for Russia."

The same or similar views are widely held in the United States, and endorsed by many of our public men irrespective of their opinions as to the wisdom of our tariff laws.

In a work published a few years ago, one of our leading statesmen said:—"To be entirely free, trade must encounter no obstruction in the way of tax, either upon export or import. In that sense no nation has ever enjoyed free trade. As contradistinguished from the theory of pro-

tection, England has realised freedom of trade by taxing only that class of imports which meet no competition in home production, thus excluding all pretence of favour or advantage to any of her domestic industries. England came to this policy, after having clogged and embarrassed trade for a long period by the most unreasonable restrictions, ruthlessly enforced, without regard to the interests, or even rights, of others. She had more than 400 Acts of Parliament regulating the tax on imports, under the designation of 'tonnage and poundage' adjusted, as the phrase indicates, to heavy and light commodities. Beyond these, she had a cumbersome system of laws, regulating, and, in many cases, prohibiting the exportation of articles, which might teach to other nations the skill by which she herself prospered."

"When, by long experiment and persistent effort, England had carried her fabrics to perfection; when, by the large accumulation of wealth and the force of reserve capital, she could command facilities which poorer nations could not rival; when, by the talent of her inventors, developed under the stimulus of large reward, she had surpassed all other countries in the magnitude and effectiveness of her machinery, she proclaimed free trade, and persuasively urged it upon all lands with which she had commercial intercourse. Maintaining the most arbitrary and complicated system of protection, so long as her statesmen considered that policy advantageous, she resorted to free trade only when she felt able to invade the domestic markets of other countries, and undersell the fabrics produced by struggling artisans, who were sustained by weaker capital and by less advanced skill. So long as there was danger that her own marts might be invaded, and the products of her looms and forges undersold at home, she rigidly excluded the competing fabric, and held her own market for her own wares. England was, however, neither consistent or candid in her advocacy and establishment of free trade. She did not apply it to all departments of her enterprise, but only to those in which she felt confident that she could defy competition. Long after the triumph in free trade in manufactures, as proclaimed in 1846, England continued to violate every principle of her own creed in the protection she extended to her navigation interests. She had nothing to fear from the United States in the domain of manufactures, and she, therefore, asked us to give her the unrestricted benefit of our markets in exchange for a similar privilege which she offered to us in her markets. But on the sea we were steadily gaining upon her, and in 1850-55 were nearly equal to her in aggregate tonnage. We could build wooden vessels at less cost than England, and our ships excelled hers in speed. When steam began to compete with sail, she saw her advantage. She could build engines at less cost than we, and when, soon afterwards, her shipbuilders began to construct the entire steamer of iron, her advantages became evident to the whole world. England was not content, however, with the superiority which these circumstances gave to her. She did not wait for her own theory of free trade to work out its legitimate results, but forthwith stimulated the growth of her steam marine by the most enormous bounties ever paid by any nation to any enterprise. To a single line of steamers, running alternate weeks from Liverpool to Boston and New York, she paid $900,000 annually, and continued to pay at this extravagant rate for at least 20 years. In all channels of trade where steam could be employed she paid lavish subsidies, and literally destroyed fair competition, and created for herself a practical monopoly in the building of iron steamers, and a superior share in the ocean traffic of the world. But every step she took in the protection of her steam marine, by the payment of bounty, was in flat contradiction of the creed which she was at the same time advocating in those departments of trade where she could conquer her competitors without bounty. With her superiority in navigation attained, and made secure through the instrumentality of subsidies, England could afford to withdraw them. Her ships no longer needed them. Thereupon, with a promptness which would be amusing if it did not have so serious a side for America, she proceeded to inveigh through all her organs of public opinion against the discarded and condemned policy of granting subsidies to ocean steamers. Her course in effect is an exact repetition of that in regard to protection of manufactures, but as it is exhibited before a new generation, the inconsistency is not so readily apprehended nor so keenly appreciated as it should be on this side of the Atlantic. Even now there is good reason for believing that many lines of English steamers, in their effort to seize the trade to the exclusion of rivals, are paid such extravagant rates for the carrying of letters, as practically to amount to a bounty, thus confirming to the present day (1884) the fact that no nation has ever been so persistently and so

jealously protective in her policy as England, so long as the stimulus of protection is needed to give her the command of trade. What is true of England is true in greater or less degree of all other European nations. They have each in turn regulated the adoption of free trade by the ratio of their progress towards the point where they could overcome competition. In all those departments of trade, where competition could overcome them, they have been quick to interpose protective measures for the benefit of their own people."

That the above views are not held by foreigners alone is shown by an article which appeared in your own *Pall Mall Gazette*, a representative of high-class journalism in Great Britain, on June 9th of last year. The same article gives reasons which are historical for the decline in certain lines of British exports:—"The fact that Bombay yarn is supplanting the Manchester article in China was pointed out by the Director of Imperial Maritime Customs four or five years ago. It was found that the Bombay yarn, woven into cloth, had more durable qualities—so it may perhaps be said that Manchester millowners have only themselves to thank for the diminished demand for their goods in this part of the world. They did not give the Chinaman the kind of yarn he wanted. The history of cotton-milling in India is curious in many ways. When the East India Company first traded in the eastern seas, Indian cotton fabrics were without a rival in European markets. The beautiful muslins of Dacca, which were famous when Babylonian and Assyrian kings ruled Western Asia, were among the wares first brought to England by the old East India Company. In 1787, according to Sir George Birdwood, the value of the imports of these muslins into England was estimated at 30 lakhs of rupees, say £300,000. But the invention of the mule jenny in England was presently followed by a cry for the protection of the British manufacturer. A heavy duty was imposed on all Indian cotton goods, and the manufacture of Dacca muslins was killed. But India was to have its revenge. In 1857, the year of the Mutiny, the first steam-loom mill was opened in Bombay. In 1878, there were 58 cotton mills at work in India. In 1890, there were 114 mills, with nearly 3,000,000 spindles; and Indian goods, as we have seen, compete with English manufactures in the markets of China, Africa, and Western Asia. Nor is it easy to see where the development of this industry will stop. Labour is cheap, the staple is grown on the spot, and the native capitalist is just as keen as any Englishman to push his wares. He cannot, of course, compete as yet with his English rivals in the manufacture of the higher kinds of cotton goods, and the 'shortness' of the Indian fibre is still a great difficulty; but the limit of production, both in quality and quantity, is very far from being attained, and English cotton goods must in the future yield still more to the Indian article." Your own Carlyle said that "free trade was the most intense nonsense that ever provoked human patience. The people of Australia were quite right to protect their industries and teach their young men trades, in complete disregard of Parliamentary and platform palaver. No nation ever got manufactures in any other way."

From the passage of the Navigation Acts, down to the close of the last century, you will find on your statute-books every phase of protective legislation which the minds of man could devise; home manufactures were forbidden in the American colonies; their woollen industry was suppressed in 1719; all iron manufactures were forbidden; even colonial hatters were not allowed to send hats from one colony to another. Perhaps it was at this time that he was driven into such a state of mind that "mad as a hatter" became a proverb. Lord Chatham said, in a speech in Parliament, that "the British colonist of North America had no right to manufacture a nail for a horseshoe." But the end of the 18th century brought with it not only the independence of the United States, and a political revolution in France, but also an industrial revolution in England, little, if at all, less far-reaching in its results than the other two events, which will for ever hold such a prominent place in the history of the world; though no great national monuments have been raised to the men whose genius worked this peaceful revolution, and gave to the world the steam-engine, the spindles, and the loom, which placed the most comfortable clothing in reach of the poorest, and, at the same time, laid a large section of the foundation of England's wealth, and political, as well as commercial, greatness. It was these inventions which enabled England to clothe the nations of Europe at large profit to herself, while the latter were engaged in destructive wars.

Some idea of the industrial revolution brought about by these inventions, and of the power of the enormous engine which they placed in England's hands for crushing out all

competition in the struggle for commercial supremacy, may be arrived at from a statement made by Edward Baines, in his "History of the Cotton Manufactures," published in 1835, that the "150,000 workmen in the spinning mills produced as much yarn as 40,000,000—the whole present population of Great Britain—could with the one-thread wheels. A spinner produced as much in a day as he produced in a year in the last century; one man and one boy print as many goods as a hundred men and a hundred boys could have printed formerly." Notwithstanding the enormous advantage which the wonderful invention above alluded to gave England, the manufacturers sought, and obtained, protection against foreign competition, which protection lasted until other advantages more than compensated for its abolition to their advantage. And so, if we follow the history of your customs' tariff down to the final repeal of the Corn Laws, 1846-49, we will find that even the passage of this Act of repeal, which was heralded abroad as a great triumph of principle by Cobden and his followers, was not entirely due to the faith of the majority who voted for it in the economic theory which was preached as a new gospel for suffering humanity. Confirming the above statement the never failing Gibbins says:—"It is curious to note how the Factory Acts were passed in the first instance; these Acts all showed the steady advance of the principle of State interference with labour; a doctrine not distasteful to the old Ricardian school of economists, even when that interference was made in the interests of the physical and moral well being not only of the industrial classes, but of the community at large. Hence the economists aided the manufacturers of the day in opposing the Acts to the utmost of their power, and the laws passed were due to the action of the Tories and the landowners, but the millowners had their revenge afterward when they helped to repeal the Corn Laws in spite of the protest of the landlords who did not mind the workmen having shorter hours at other people's expense, but objected to their having cheaper bread at their own."

So many and so severe have been the criticisms upon the tariff legislation of the United States—termed hostile to England by some of its critics—both in your newspapers and in some instances in the correspondence of English manufacturers who have been invited to be exhibitors at Chicago in 1893, that it seemed necessary to me, at the risk of wearying you to hold up before you the reverse side of the picture, England's free trade policy as viewed by us in the United States, with some of the facts in history upon which that view is founded. Once more I say without expressing any opinion myself upon the right or wrong or expediency of either policy.

Whenever and wherever in England the coming Exposition has been discussed, whether in the drawing-room or the counting-house; in the correspondence of your Secretary with those who are in position to best represent Great Britain and Ireland, the McKinley tariff has been brought forward as an impassable obstacle, and as a piece of political legislation absolutely without precedent, and hostility to England has been proclaimed by many as the motive behind it, but the absurdity of this view is now seen by the intelligent observer of events who has a knowledge of your own commercial history. Self-interest is the motive for such legislation; and when intelligently and properly directed, a worthy motive, which enters into every action of individuals and nations, never absent in the case of the latter. During all of the period, the history of which I have hastily, and, as briefly as possible, reviewed, down to and including the passage of the Corn Laws, this was the controlling motive of your Parliament at Westminster, and it is national self-interest, as understood by its members, which govern the Congress of the United States at Washington. As to the wisdom or right displayed in any act at either place I have expressed no opinion, I would have failed in my duty to you, and to the interests which I represent, had I left unnoticed on this occasion the criticisms, private and public, which have been freely expressed of our recent tariff legislation, and the way I have treated the subject was the only one open to me. Probably I would not have given this part of my paper so much space, or devoted so much time to laying the above facts before you, had your Secretary not asked me to read a paper on the McKinley tariff, which he recognised himself, on a word from me, as hardly appropriate for me in my official position.

PART II.—FUTURE TRADE RELATIONS.

We can now pass on to the more practical part of my subject—especially practical at this time, as it involves the question which your manufacturers and merchants have to decide without further delay—"How large and how representative shall the exhibits of British and Irish industry be at the forthcoming Columbian Exposition?" The British Colonies, while slow at first, are now putting forth every effort to

secure such a representation of their products, natural and manufactured as has never been made before. I therefore leave them out in formulating the above query.

The future trade relations between Great Britain and the United States is the subject with which I have directly to deal. Considering the present trade relations, notwithstanding our new Customs' tariff, it is a matter of constant surprise to me that your manufacturers, without regard to their being directly, and in that sense personally, interested in the trade with the United States on account of exporting their own products thither, have not vied with each other, not only in themselves becoming exhibitors, but in co-operating in every way with your Council, appointed the Royal Commission, to take care of the interests of Great Britain and Ireland at the forthcoming Exposition. It is to the interest of every one of your manufacturers, even those who export no part of their product to the United States, that no question be left in the mind of the visitor at Chicago in 1893—whether he come from one of your own colonies or from South America; from Canada on the North to Cape Horn on the South; from India, from tradition in the East, to Australia in the West; that no question be left in the mind of the visitor at Chicago in 1893, as above said, as to the place which you hold and have held so long in the commercial world, which place will be indicated to thousands of those visitors by the comparison which they will make between the British section and the German, or the French, or the American section, and by American I mean the United States. From all over the world will come the shrewdest merchants of every nation, not for pleasure only, but also, yes mainly, to see whether or not they can purchase in the United States or Germany perchance, the articles which they do not produce themselves, to better advantage than from countries which have hitherto benefited by their patronage, England prominently.

Before entering upon the discussion of my subject, I must first repeat the statement which I made from this platform on the evening of December the 11th last; that the United States is by far your best customer, and here give you the list of your twelve best customers placed before you on that occasion. So far is the United States in the lead, that in racing parlance, appropriate not only to this country, but also to this occasion for reasons which will be clear to you, there is not a good second in the field; for the United States buys from you fifty per cent. more than Germany, your second best customer. Here is the list, which some of you will doubtless remember:—

COMPARATIVE STATEMENT OF THE EXPORTS OF GREAT BRITAIN AND IRELAND FOR THE YEARS 1890 AND 1891, TO THE COUNTRIES WHICH RANK AS HER TWELVE BEST CUSTOMERS.

Countries to which Exported.	1890.	1891.	Increase.	Decrease.
	£	£	£	£
United States	32,068,128	27,544,720	..	4,523,408
Germany	19,293,626	18,859,544	..	434,082
France	16,567,927	16,430,542	..	137,385
Turkish Dominions	10,324,374	10,518,324	193,950	..
Holland	10,121,160	9,439,910	..	681,250
Brazil	7,458,628	8,288,534	829,906	..
Belgium	7,638,712	7,353,839	..	284,873
Italy	7,757,862	6,293,437	..	1,464,425
China (exclusive of Hong Kong)	6,608,982	6,455,776	..	153,206
Russia	5,751,601	5,413,093	..	338,508
Spain (including Canary Islands)	5,466,045	5,431,820	..	34,225
Argentine Republic (including Atlantic coast of Patagonia)	8,416,112	4,240,602	..	4,175,510
Total	£137,473,157	£126,270,141	£1,023,856	£12,226,872

I append the Table for examination at your leisure. Coupled with other similar statements with which I will furnish you, it may lead some of your manufacturers now hesitating about being exhibitors at Chicago in 1893, to lose no more time in making a worthy display in order that they may have a "place"—again resorting to racing parlance—in the contest which will be concentrated, for the time being, at the World's Columbian Exposition. In measuring the benefits derived from exports, you — and especially the British

manufacturer who has no direct interest in the exports to the United States—must bring yourselves to appreciate the fact that in whatever proportion the United States is a customer for any given article, they help in like proportion to support the industries which find no market in the United States, but are dependent upon the cotton manufacturer, for example, who does; the engineers and machinery builders; the owners of your coal mines and the miners who work them; your railway companies, which transport the raw material and the finished product to and from the mill; your steamship companies, which have a monopoly, aided by our tariff, in the transportation of raw material from and purchased product to the United States; and even your landowners.

To show over what a wide range of industries your exports to the United States are spread—ramifying in their benefits through other industries as above indicated—and how distributed between the manufacturing centres of Great Britain and Ireland, I here insert a list of 105 principal articles with which you supply us, and the names of the places from which they are shipped. (See pp. 533-4.)

These go in varying quantities from Belfast, Birmingham, Bradford, Bristol, Cardiff, Cork, Dublin, Dundee, Dunfermline, Falmouth, Glasgow, Huddersfield, Hull, Leeds, Leith, Liverpool, London, Manchester, Newcastle, Nottingham, Plymouth, Sheffield, Southampton, and Tunstall.

This list develops the fact that the manufacturers who have the largest share in the trade with the country which is your best customer, are the ones who have complained the most bitterly about our recent tariff legislation. On the real effect of this legislation I will have something to say later on, as it, of course, bears upon the question we are dealing with. Owing to my having been called on to read this paper now instead of a fortnight later, the returns for 1891 are not accessible, and, therefore, the list is for the last quarter of 1891. I see from this list that drugs and chemicals are the largest in amount. Woollen and worsted goods, with the addition of stuff goods, which are a mixture of woollen, take second place with a total of approximately £700,000, with an increase over 1890 of about £125,000; next comes tin plates, and after this linens, with cotton following close behind; after that iron and steel manufactures, and then glass, china, and earthenware, of which I am glad to know that a firm well known to you all, and bearing a name with which the rolls of this Society are honoured and known in America as well as England, is going to make a splendid exhibit at Chicago, in 1893. I must read to you here the increase and decrease in the twelve articles largest in amount on the above list of exports, and then pass on to the point they naturally bring me to—the effect of our present tariff upon the present trade relations of the United Kingdom and the United States. (See Table, p. 535.)

Looking over the above list, and seeing that at or near the top are the manufacturers who have grumbled the most about our new tariff, I am reminded of what an Irish or an English friend—perhaps your Secretary—I hope he will not shirk it if I say it was he—at least in so far as it pertains to Englishmen—told me, as a proverb all over the United Kingdom, "That an Irishman was never at peace except when he was in a fight; an Englishman never happy except when he was grumbling; and a Scotchman never at home except when he was abroad." I mention the Irishman and the Scotchman, with both of which I am allied by blood, as I do not wish to slight my own kinsmen. It must be concluded, then, that your cotton and woollen manufacturers are happy, and they have reason to be, as have all of your manufacturers, at the results so far of the McKinley Tariff. Let us see what these results have been, and how far and in what direction the variations in your trade are due to the tariff. To do this we must first compare the exports of the United Kingdom to the United States for last year with 1890, on October 6th, of which year the new tariff went into effect—being in effect practically for the last quarter of that year.

Then, or secondly, we must examine into other causes which were actively at work to bring about a shrinkage in your trade, not only with the United States, but with every part of the world, before the tariff went into effect, and entirely independent of it, and culminating after.

Next, or in the third place, we must examine into the conditions of trade generally preceding the great Baring failure, and ask in how far these conditions would have operated to prevent any increase in 1890 over 1889, if they did not actually work a decrease, without the stimulus of profit growing out of the advance in prices resulting from the tariff.

In the fourth place, we must compare the

VALUES OF PRINCIPAL ARTICLES OF EXPORT FROM THE UNITED KINGDOM TO THE UNITED STATES FOR THE QUARTER ENDED DECEMBER 31ST, 1891.

ARTICLES.	1891.	1890.	Increase.	Decrease.	Increase.	Decrease.
	dols.	dols.	dols.	dols.	£	£
Animals	95,073.32	120,668.63	..	25,593.31	..	5,119
Antimony	68,575.25	..	..	..	..	..
Artificial flowers	85,241.19	..	..	..	..	..
Bags and bagging	104,744.17	..	..	..	..	..
Beer, ale, and stout	490,217.89	438,364.88	51,853.01	..	10,370	..
Blacking	2,615.13	..	..	..	..	..
Books	677,079.49	471,815.24	205,264.25	..	41,053	..
Bricks and tiles	98,409.40	..	..	..	..	..
Bristles	18,720.04	..	..	..	..	..
Brushes, tooth and hair	21,699.17	..	..	..	..	..
Burlaps	1,862,706.90	1,290,778·31	571,928.59	..	114,385	..
Buttons	15,029.52	2,422·95	12,606.57	..	2,521	..
Card clothing	46,974.13	49,885.19	..	2,911.06	..	582
Carpets	150,275.22	166,439.64	..	16,154.42	..	3,231
Cement	284,441.83	371,826.31	..	87,384.48	..	17,477
Chalk	18,401.16	..	..	..	..	..
China clay	95,486.74	90,370.81	5,115.93	..	1,023	..
Clocks and watches	11,271.13	..	..	..	..	..
Coal and coke	309,286.01	210,777.40	98,508.61	..	19,701	..
Cocoa and chocolate	47,003.76	53,049.46	..	6,045.70	..	1,209
Coffee	75,491.21	17,882.86	57,608.35	..	11,521	..
Colours, paints, and varnishes	202,387.73	129,566.95	72,820.78	..	14,564	..
Confectionery	13,130.35	..	..	..	..	..
Cotton	233,413.47	..	..	..	..	..
Cotton manufactures	2,245,893.53	2,114,960.69	130,932.84	..	26,186	..
Cutlery	205,909.83	139,907.98	66,001.85	..	13,200	..
Cycles	66,711.29	..	..	..	..	..
Drugs and chemicals	3,693,759.27	3,010,683.70	683,075.57	..	136,615	..
Elastic	84,736.56	..	..	..	..	..
Emery	6,315.14	..	..	..	..	..
Feathers	91,936.41	256,599.37	..	164,662.96	..	32,932
Fish	210,970.28	..	..	..	..	..
Floorcloth	30,026.31	18,151.74	11,874 57	..	2,375	..
Fruits, nuts, and vegetables	491,527.80	738,503.66	..	246,975.86	..	49,395
Fuller's earth	19,435.89	..	..	..	..	..
Furniture	41,294.07	..	..	..	..	..
Glass, china, and earthenware	1,232,778.32	1,071,436.66	161,341.66	..	32,268	..
Gloves, hosiery, &c.	182,129.47	186,877.86	..	4,748.39	..	949
Glue and gelatine	82,100.82	..	..	..	..	..
Grease	67,937.52	..	..	..	..	..
Gums	70,785.21	..	..	..	..	..
Hair—cow, calf, &c.	59,222.72	97,276·05	..	38,053.33	..	7,610
Hardware	386,543.21	313,053.02	73,490.19	..	14,698	..
Hats	24,917.69	..	..	..	..	..
Hemp, flax, and tow*	1,128,367.71	1,172,751.39	..	44,383.68	..	8,876
Indigo	28,760.00	..	..	..	..	..
Ivory	35,465.01	..	..	..	..	..
Jute	24,118.97	33,251.45	..	9,132.48	..	1,826
Laces	937,561.46	1,052,540.92	..	114,979.46	..	22,996
Leather	235,770.59	454,710.43	..	218,939.84	..	43,788
Linens	2,647,394.56	2,547,786.83	99,607.73	..	19,921	..
Linseed	..	..	..	..	..	..
Machinery	706,438.98	609,549.98	96,889.00	..	19,378	..

Articles.	1890.	1891.	Increase.	Decrease.	Increase.	Decrease.
	dols.	dols.	dols.	dols.	£	£
Matches	4,250.17	..	..	..	..	..
Metals—iron and steel and manufactures	1,246,537.91	1,627,899.42	..	381,361.51	..	76,272
Metals—other	154,000.77	..	..	..	..	..
Mustard	48,430.01	..	..	..	..	..
Oils	84,348.69	..	..	..	..	..
Ores, iron, &c.	158,356.25	..	..	..	..	..
Paper and paperhangings	100,099.72	..	..	..	..	..
Paper stock	468,117.94	439,940.84	28,177.10	..	5,635	..
Perfumery	17,001.60	..	..	..	..	..
Pitch and tar	105,695.41	..	..	..	..	..
Plumbago	1,505.05	..	..	..	..	..
Precious stones	591,215.07	364,440.59	226,774.48	..	45,355	..
Preserves, pickles, &c.	155,295.03	261,078.13	..	105,783.20	..	21,156
Provisions, cheese, bacon, &c	43,698.20	..	..	..	..	..
Quicksilver	320,361.40	..	..	..	..	..
Rice	78,440,85	..	..	..	..	..
Rope	12,062.88	..	..	..	..	..
Rubber, raw	674,736 68	344,688.56	330,048.42	..	66,009	..
Rubber—clothing and manufactures	41,985.90	..	..	..	..	..
Saddlery	52,471.62	66,396.82	..	13,925.20	..	2,785
Salt	193,290.17	..	..	..	..	..
Sausage casings	49,103.14	1,677.65	47,425.49	..	9,485	..
Scientific & optical instruments	22,289.61	..	..	..	..	..
Seeds, plants, &c.	122,869.47	233,463.26	..	110,593.79	..	22,118
Shellac	21,250.15	..	..	..	..	..
Shells	110,107.91	..	..	..	..	..
Silks	216,926.16	313,572.64	..	96,646.48	..	19,329
Soaps	64,330.10	..	..	..	..	..
Skins, furs, &c.	1,952,797.54	2,535,838.73	..	583,041.19	..	116,608
Spices	116,507.57	152,876.80	..	36,369.23	..	7,274
Sponges	9,750.15	..	..	..	..	..
Stationery	102,314.19	48,265.76	54,048,43	..	10,809	..
Sticks and canes	27,213.15	..	..	..	..	..
Straw plait and braids	212,107.03	..	..	..	..	..
Straw manufactures	1,210.60	..	..	..	..	..
Stuff goods	1,111,133.18	1,089,190.58	21,942.60	..	4,388	..
Stone, marble, granite, &c.	92,081.19	..	..	..	..	..
Sugar	20,118.21	..	..	..	..	..
Tea	825,750.31	99,368.70	726,381.61	..	145,276	..
Thread†	114,403.26	813,536.68	..	..	..	..
Tin	401,316.12	376,559 95	24,756.17	..	4,951	..
Tinplates	2,834,026.58	6,947,195.24	..	4,113,168.66	..	822,633
Tobacco and cigarettes	52,232.14	..	..	..	..	..
Unions	129,891.39	542,762.62	..	412,871.23	..	82,574
Wearing apparel	27,361.14	62,605.95	..	35,244.81	..	7,049
Wines and spirits	152,952.35	131,495.65	21,456.70	..	4,291	..
Woods	31,783.15	..	..	..	..	..
Wool and camel and goat hair	1,763,197.72	1,867,227.98	..	104,030.26	..	20,806
Woollen and worsted goods	2,358,709.33	1,764,733.88	593,975.45	..	118,795	..
Works of art	71,726.61	202,487.06	..	130,760.45	..	26,152
Yarn†	489,131.93	..	..	..	..	..
All other articles	4,284,695.63	6,521,436.66	..	2,236,741.03	..	447,348
	42,407,671.46	44,174,692.45	..	1,767,020.99	..	353,404

* Included in "All other Articles" in 1891. † Yarn and Thread were included under one total in 1890.

Decrease in exports tin-plates, quarter ending Dec. 31, 1891	\$4,113,162
Decrease in total exports, quarter ending Dec. 31, 1801....	1,767,021
Showing increase in articles other than tin-plates........	\$2,346,148
Or £469,222.	

decrease in your exports to the United States with the corresponding decrease to other nations of such rank in commercial importance in their relations with you as to be worthy of special mention.

In the fifth place we must ask what natural causes are at work, aside from the tariff, which may be called artificial, to check for a time, if temporary, your exports to the United States, or if permanent, to ultimately bring about a steady decrease in them, or in some of them, to be replaced perhaps by something else. And then you must ask yourselves how far disagreement between labour and capital has operated, and will operate to further complicate the question, and then if you will allow me to add to the puzzle, one query for your textile manufacturers of Manchester and Bradford especially, how much of the loss in their trade is due to change in styles, fickle as the wind, which they themselves are moving too much in a groove to anticipate. Upon the two last I will have nothing to say.

I find support for the line I have chosen in the above questions, and the causes for declining trade, which many of your manufacturers at least haver efused to consider, in a daily paper of recognised standing. "During the last few years," says the *St. James's Gazette* of the 1st instant, "the country has passed through a serious crisis. The contraction of trade, due in a large measure to over production and over speculation, the collapse of two great financial houses, the hostile tariffs" — note the characterisation "hostile"—in America and elsewhere, and the labour troubles have had "far less effect than could have been anticipated," the reason given being of a character with which we have nothing to do.

Now for our questions *seriatim*.

The exports from the United Kingdom to the United States in 1890, as shown by the tabular statement above given, amounted in value to £32,068,128 out of a total of exports of £176,160,202, the United States taking 18 1-5th per cent. of the total, while in 1891 your exports to the United States amounted to the value of £27,544,720 out of a total of £161,305,487, the United States taking 17 per cent. of the total; a loss of one and one-fifth (1 1-5th) per cent. But an artificial stimulant had been administered in 1890 in the shape of the tariff proclaimed as coming, and inducing heavy buying in anticipation thereof. In the first quarter of 1890, as compared with 1889, there had been a falling off

Increase and Decrease and Movement of Twelve Leading Articles of Export from Great Britain to the United States for the Quarters ending Dec. 31, 1890, and Dec. 31, 1891.

Articles.	1890.	1891.	Increase.	Decrease.	Place of Production.
	£	£	£	£	
Tinplates	1,389,439	566,805	..	822,634	South Wales.
Drugs and Chemicals ..	602,136	738,751	136,615	..	Liverpool, London.
Woollen and Worsted and Stuff Goods	570,773	693,968	123,195	..	Bradford, Huddersfield, Leeds.
Linens	509,557	529,478	19 921	..	Belfast, Manchester, Glasgow.
Skins, Furs, &c.	507,167	390,559	..	116,608	London.
Cotton Manufactures ..	422,992	449,178	26,186	..	Manchester, Glasgow.
Wool and Camel and Goats' Hair	373,445	352,639	..	20,806	London, Liverpool.
Iron and Steel Manufactures	325,579	249,307	..	76,272	Liverpool, Birmingham, Glasgow, Sheffield.
Burlaps	258,155	372,541	114,386	..	Dundee.
Glass, China, & Earthenware	214,287	246,555	32,268	..	Burslem, Birmingham.
Laces	210,508	187,512	..	22,996	Nottingham.
Machinery	121,909	141,287	19,378	..	Manchester, Bradford, London.

in the exports to the United States to the amount of £566,302, followed by a reaction which, considering other concurrent incidents, could not have been expected without the stimulant above alluded to. Under its powerful influence the second and third quarters of 1890 showed an increase over 1889 of £2,600,801. The whole of this increase is considered by those in the most favourable position to judge of the causes which produced it, to be due to purchases made in anticipation of the advance in prices growing out of the new tariff. The whole amount of this increase, to properly compare the two years therefore, should be deducted from the total of 1890 and added to that of 1891, the result of which would be that your exports in the former year (1890) would show a total of £29,467,327, and of the latter (1891) a total of £30,145,621, providing that other concurrent events above alluded to had not intervened to check your trade with us, and had our merchants purchased as freely in the ordinary course of trade without the stimulus of speculative profit.

But the trade of 1891 also was helped by the artificial stimulant of the increased duty on tin plates taking effect on July 1st of that year, your exports of that article showing an increase for the year 1891 over the year 1890 of £480,000, notwithstanding the heavy decrease in the last half of the former year, as indicated by the figures for the last quarter, given above. Leaving tin plates out of our calculation, your exports to the United States for the last quarter of 1891 show an increase of approximately £470,000, some of the items of which increase I have given above. It will be time enough to deal with the actual and permanent result of the tariff when we are far enough away from the passage of the Tariff Act to judge of it. What the owners of your tin mines have most to fear is our finding tin in the United States in such quantities, and of such quality, as to enable us to dispense entirely with the duty. Quoting from an article by Mr. Andrew Carnegie, in the *Nineteenth Century*, for June of last year, "It may now be noted that prices in Europe and the United States, for everything, draw nearer and nearer together. In recent times, steel rails, for instance, have sometimes been quite as cheap in New York as in London, and very often as as cheap as foreign rails could have been imported to New York free of duty."

There is a clause in the McKinley Tariff Bill, of which I have heard no complaint, but which has a more important bearing upon your manufacturing interests than its protective features, it reads:—"That where imported materials on which duties have been paid are used in the manufacture of articles manufactured or produced in the United States, there shall be allowed on the exportation of such articles a drawback, equal in amount to the duties paid on the materials used, less one per centum of such duties."

As for the second question, the causes other than the tariff which operated to bring about and intensify the shrinkage in your foreign trade generally, these are too recent, and their effect too deep and widespread in this community to require more than passing notice from me. These causes other than the tariff —"over-production, over-speculation, the collapse of two great financial houses," with possible results so serious as to justify the Bank of England stepping in and borrowing large sums abroad, to arrest a disaster from which you could not have recovered for years, with the most profitable trade at home and abroad. In what relation did the United States stand to you at this juncture? First of all, just prior to this crisis, she increased enormously her purchases from your manufacturers, enabling them to reduce their discounts with their bankers when money was worth a premium. Following these increased purchases, they bought back securities to an amount far larger than the loan sought for and made by the Bank of England from the Bank of France, thus rendering a service even to the manufacturers, who must depend largely upon the banks, more than off-setting in advantage the whole decrease in your exports to the United States for the last quarter of 1890, had this loss of trade been an actual and permanent loss instead of no loss at all, but only a transfer of the transaction to an earlier period of the year.

I have already anticipated my third heading, and will now only note it to point out to you the beginning of the shrinkage in your trade. The collapse in Argentine as first indicated in a decline in your exports to that Republic, from the high-water mark of 1889—£10,681,879 to £8,416,112 in 1890, and then to £4,240,602 in 1891—to say nothing about the losses there from "over-trading and speculation." Fair crops in 1890, and large crops in 1891 in the United States, and an unprecedented demand for our breadstuffs during the last quarter of 1891, making business of all kinds good with us, and enhancing our purchasing power, was the balance

wheel which saved the world from a financial disaster, such as history hardly records. What the conditions were in the financial capitals of other countries is well known to all of you. They had all the securities they could stagger under.

We now come to our fifth question, What natural causes are at work, aside from the tariff, which may be called artificial, to check your exports to the United States, and in time, if permanent, bring about a steady decrease in them or some of them, to be replaced perhaps by something else ? and I will add here, What are the natural impediments in the way of these natural causes, which may tend to defer for years to come their full fruition without some aid; as the mountain deflects from its straight course, the mighty river, which in time cuts its way through solid rock, unaided by dynamite, or blasting, or other modern inventions, artificial, as is the tariff, but still when applied with proper limitations as to time and place, circumstance and quantity, only brings about, though hastening, results in accordance with natural laws. As to the first part of this question, there are several causes at work, aside from the tariff, not only to cut off your exports, especially of cotton goods to the United States, which are only one and fifteen one hundredths of one per cent. of your total export of cotton goods, but also to bring the United States to the fore as a competitor in this line of manufacture in your other foreign markets, prominently in South America, China, and Japan. It is no more in accordance with natural laws for you to bring the cotton from the United States, and send the manufactured article to countries in closer proximity than you yourself to the cotton fields, than it was for you in the 16th century to send your wool to Flanders to be manufactured and distributed from there to the consumer. The place for the cotton mill is in or adjoining the cotton field, and there the next generation at the latest will find it in its most prosperous condition. Until about the year 1890, after the period of reconstruction following the "late unpleasantness" as we now call the late war, the South was purely agricultural, with no ambition to be anything else. It was only a question whether their cotton would be sent to New England or Old England, and Baines, in his History of the Cotton Manufactures, tells us that the difference between the freight on cotton from New Orleans to Boston and New Orleans to Liverpool, was a quarter of a penny per lb. But as the discovery of coal and iron in the north of England (in Lancashire) resulted in your cotton mills and other manufactures locating there, so the discovery of iron and coal in Alabama opens the way for the construction and operation of mills to as great advantage in or adjacent to the cotton fields. The new south is to the United States what the west was fifty years ago—the place for men with brains, experience, and capital—such as some of your cotton manufacturers at Manchester and Bradford. Twenty-five years ago, any railroad manager of prominence, or anyone versed in railroad affairs, would have told you there was no money in lines running north and south, that only lines connecting the east with the west could pay. But now the west, rich herself, is reaching out southward as is the east, and capital is flowing into the southern States for the development of her industries. So large and so important have become the agricultural and industrial interests of our Pacific coast, and the traffic between it and the Atlantic coast, that with the capital for such works, we have not only been brought to the recognition of the importance of a waterway for ocean steamships between the two, but a company has been organised for the construction of a ship canal across the Isthmus of Nicaragua. But the results of the construction of this canal will reach beyond the boundaries of the North American continent; shifting some of the existing avenues of commerce thousands of miles. "The discovery of the passage by the Cape of Good Hope destroyed the overland trade with the East, and overthrew the commercial supremacy of the Mediterranean cities. The Suez Canal in like manner so superseded the passage by the Cape of Good Hope, that the discovery by the Portuguese has become nearly as sterile as that of the Carthagians told of by Herodotus. It is the medium of commercial intercourse between Europe and Western and Southern Asia." How will the opening of the Nicaragua Canal affect the present channels of trade and the present trade relations, especially the trade relations between Great Britain and the United States? How will it alter the relative distances between New York, on the one hand, and Liverpool, on the other, from the markets of the Pacific coast of both North and South America, and the ports of China and Japan, and India and Australia? "New York and Liverpool by 'The Horn' are equally distant from San Francisco, viz., 15,600 miles, and the same is true of all other ports on the Pacific coast," says the Hon. Warner Miller, Presi-

dent of the Nicaraguan Canal Company, in an article in the *Forum* for February. "By the canal, New York will be distant from San Francisco 4,900 miles, whilst Liverpool will be distant from San Francisco 7,600, or a difference in favour of New York of 2,700 miles; and this difference in favour of New York over Liverpool holds good as to all the ports on the Pacific coast of both North and South America. To-day Europe controls more than three-fourths of all the trade on the Pacific coast of both North and South America. With the canal constructed, giving the merchants of the Atlantic coast 2,700 miles of advantage over Europe, they will be able to secure the bulk of that valuable commerce. At the present time there are more than 70,000,000 people on the islands in and continents bordering on the Pacific Ocean, who will be brought nearer to New York by distances varying from 3,000 to 10,000 miles, and, taking no account of the vast population of China and India," all markets now under the control of the British manufacturer. "Shanghai is 300 miles nearer New York by the Nicaragua Canal than Liverpool by the Suez, and New York 2,000 miles nearer Yokohama than Liverpool by the Suez, thus giving New York an advantage over Liverpool in competing for the trade of Japan. Melbourne in Australia, and Auckland in New Zealand, are brought 4,000 miles nearer New York by the canal than by 'The Horn.'"

Bombay and Calcutta, the ports of your great Empire in India, are 7,000 or 8,000 miles from Liverpool by the Suez Canal, and to-day you are drawing large quantities of wheat from India over a line which is 8,000 miles shorter than the distance round the "Horn" from Liverpool to San Francisco. With the completion of the Nicaragua Canal this difference is wiped out. From ports in the Gulf of Mexico —New Orleans, Mobile and Galviston—the distance is only 1,200 miles from the western mouth of the canal, which is 800 miles less than the distance from New York. This will open a market for the raw cotton of the South in Japan where 40,000,000 of people use cotton as their chief article of clothing. With the distance from the Gulf of Mexico to Japan reduced over half, we could supply the Japanese market in competition with India; and furthermore supply India herself with the longer fibred product of our own cotton fields, for mixture with her own, the "shortness" of the fibre of which is a great difficulty in the way of the Indian manufacturer competing even on his own ground with his English rivals.

When I made my first allusion to the establishment of cotton mills in the centre of or adjacent to the cotton fields in the South, and from it passed on to the effect on this trade and the trade of the United States generally with the west coast of both Americas, of the opening of the Nicaragua Canal, and what is to us the still farther west, China, Japan, and India, it was not with the intention of taking this staple, and presenting it as an illustration or example of our future trade relations. But I see no better method than this, and I shall therefore follow it. And it is peculiarly fitting that we should take the movement of cotton, a raw material, as indicative in its present and future phases of the present and future trade relations of Great Britain and the United States as I see them, and follow it through the finished product to the back of the wearer of the coat made from it, for it is typical of our exports to the United Kingdom, as it is typical of your exports to the rest of the world. More than this, it heads the list of your manufactures in value, its value being double that of your woollen manufactures, and as much as your woollen and steel and iron manufactures, including machinery and steam-engines combined, and about 22½ per cent. of your total manufactures. The value of your cotton manufactures in 1840 was £24,678,460, while in 1889 the latest figures I happen to have at hand was £62,089,442; and for this output the United States furnished you with about eighty per cent. of your raw material, the product of which you send all over the world.

Your imports from the United States are in fact raw materials without exception—breadstuff and meat products being the raw materials of, or at least sustaining brain and brawn; directly in the latter case, indirectly in the former as the fuel, the combustion of which generates the heat which runs the dynamo of the brain. Here is a list of the principal articles we sent you in 1890, in the order of their respective values:—

	£
Raw Cotton	36,571,848
Breadstuffs	19,890,486
Bacon and Hams	7,474,737
Oxen and Bulls	7,351,981
Fresh Beef	3,629,919
Tobacco	2,530,510
Cheese	2,081,546
Lard	2,049,747
Leather	2,019,359
Petroleum	1,719,654
Oil Cake	1,355,853
Total	£86,675,640

Not only are raw materials by far the largest part of our exports to Great Britain, but also of our total exports, forming 82 per cent. of that total for our fiscal year, ending June 30th, 1891; 50·62 per cent. of which total I may add you took from us, sending us 23·05 per cent. of your total exports during the same period.

The future trade relations between Great Britain and the United States will depend upon the latter's ability to convert her raw materials, which she now exports, into finished product, and sell the latter in foreign markets which you have hitherto controlled. What we expect the Nicaragua Canal to do in this direction in certain markets—the western coast of both Americas, and the farther west to us, China and Japan—I have told you above. The British manufacturer has heretofore had the advantage of cheaper coal than his competitor in the United States, but this advantage seems to have disappeared.

The average price of coal in Great Britain during the year 1889, I have seen it stated, was 6s. 6½d., or about $1·57 in American money, per gross ton of 2,240 pounds. In his recent report, the Commissioner of Labour of the United States gives 98½ cents per net ton, or $1·10 per gross ton, as the total cost of producing lump coal at ninety-nine mines in the United States; and it is stated that for two years past the best Virginia coal has been sold at tidewater at a less price than English coal is sold at Newcastle. So it would seem that England has already reached the phase when her manufacturers have not the advantage of cheap coal as compared with their competitors in the United States; and the difficulty must increase, as has recently been prognosticated by more than one writer on this economic subject. Notwithstanding the facts I have laid before you, many of you will say, in hunting parlance—appropriate to the occasion as is racing parlance—that I am "riding before the hounds," and that this generation of British manufacturers need not concern itself with anything so remote as the competition in a field foreign to both, of a country 82 per cent. of whose exports are materials raw, or having their value but slightly increased by change of form. This I will grant you, with the limitation of the near future; for already we have entered the export field; and notwithstanding the depression felt all over the world following the Baring catastrophe, for such it was, and to you especially, and the shrinkage in your own trade, the exports of manufactured articles from the United States increased 7·3 per cent. In the article of locomotives there is an increase of three for one in value, rising from $1,037,404 (equivalent to £207,481) in 1890, to $3,274,825 in 1891 (equivalent to £654,965). These locomotives have been distributed as follows:—To Cuba, $958,084 (£191,617); to Brazil, $1,837,796 (£367,557); and to your Australasian colonies, $892,295 (£178,459). There was also a gain of $1,257,151 (£251,437) on a total, in 1890, of $4,019,714 (£803,945) in road and rail cars; of £10,000 in sewing machines, nearly £17,000 in glass ware, £9,000 in locks, hinges, and builders' hardware, £14,000 in saws and tools, £15,400 in stationary engines and boilers, and £166,500 in machinery not specified. Are your engineers and machinery manufacturers going to make a display at Chicago that will check this increase, or will they (your machinery manufacturers) leave the mutually foreign field, which can be so advantageously worked at Chicago, for the American manufacturer to diligently till without contest on that important occasion, while they rest contentedly on their past achievements?

Our exports of raw cotton amount in value to about £58,000,000, while our exports of manufactured cotton only amount to about £2,721,000. These figures, as time goes on, must come together, if not reverse themselves through the operation of the agencies I have named above, and you must divide with us, at least, the trade in cotton manufactures foreign to both. With the completion of the Nicaragua Canal, the Australian wool, which now comes first to London, and is then re-exported to the United States, will come direct to our Atlantic ports, cheapening it to the American manufacturer. To-day woollen manufactures do not figure in our exports, and are not likely to be for some time; but we are large buyers of woollen goods from you, having taken about $700,000 worth of the product of your woollen mills during the last quarter of 1891, with an increase, as shown above, over the corresponding period of 1890. During the last-named year, we bought woollen goods from you to the amount of about £5,300,000. I also note in the annual statement of the trade of the United Kingdom, under the heading of "United States" exports thereto of foreign and colonial manufactures for each of the five years beginning 1886-1890, that you sent us foreign and colonial woollen manufactures valued as follows:—1886, £52,277; 1887, £123,186; 1888, £203,632; 1889, £353,642;

1890, £1,033,939. How far this enormous increase has been of a character to displace your own product I do not know, but it is a question for you to ask yourselves whether your foreign and colonial competitors are, through the aid of English merchants, cutting into your woollen trade. At present there seems no likelihood of our becoming competitors with you in woollen manufactures in markets mutually foreign, though the total of our output is three times the value of yours, the former being £66,000,000, and the latter about £20,418,482, for the year 1890.

Our iron and steel industry has overtaken and passed yours in magnitude. In 1890, our production of pig iron was 9,202,703 tons, against 7,875,703 tons in the United Kingdom; and our production of Bessemer steel, 4,031,535 tons, against 2,014,843 tons from your furnaces. Of manufacturing iron, including rails, 2,820,377 tons were produced in the United States, against 1,923,221 tons in Great Britain.

Time does not suffice for me to enter further into particulars, or to more than allude to your other industries, especially the one which has been at once the mainstay of all the others, and dependent upon their support—your shipping. I read, I think in the *Daily Telegraph*, some time last summer—at least, during the Naval Exhibition: — "Throughout all the generations we have been a people delighting to go down to the sea in ships, and prone to protect our countless fleet of merchant ships which we have sent to carry our commodities to the uttermost ends of the earth, by ships of war armed to the teeth, manned by sailors prepared to go anywhere, and ready to do anything, and commanded by officers in whose dictionary the word fear was not to be found."

I hope, as I know you do, that your navy and ours—which we are building—may never come together in battle except as allies; but with your merchant shipping we will soon be in a position to take the field as competitors in the trade of which, as above said, you have had a monopoly ever since the iron steamer displaced the clipper ship, with which we had well-nigh grasped the palm. To-day, the products of your looms and workshops which you send to us, and the bread-stuffs and raw materials with which we supply you, are carried to and fro in British bottoms, as well as the enormous number of my countrymen who visit England every year, to add not only to the revenues of your steamship lines, but also in an enormous degree to the profit of the London hotels, lodging-house and shop-keepers, and manufacturers. The tonnage of vessels entering and clearing from British ports for the United States during the year 1890, was 9,329,720 tons, of which 8,219,872 tons were British bottoms, and 259,965 were American, and this wide difference we propose to make beautifully less. "The Germans, too, who have but lately entered this field," says an English newspaper, "once all our own, are not only challenging, but beating us hand over hand. Two of their lines (the North German Lloyd and the Hamburg American) actually carried more passengers to New York than all our Liverpool vessels put together. Furthermore, they beat the swiftest of our lines in carrying the mails by no less than nine hours and fifty-seven minutes." And they are doing this at a profit.

In your future trade with the United States, whether it be as a customer, or a competitor, much will depend upon the readiness and celerity which your manufacturers manifest in the adoption of improved machinery, and in adapting themselves to the changing methods of doing business, and their output to the changing tastes and requirements of those upon whose patronage they depend—that is changes in fashion. To the lack of these—absolute requisites no matter at what cost, to success in this day and generation—is to be attributed in large part the dulness in trade of which your manufacturers are now complaining, attributing all to the McKinley Tariff. In support of this view, I will quote from a very interesting article which appeared in the *Leeds Mercury* of January 5th. Referring to "the great firms of Manchester merchant princes," says the *Mercury* going back, of yesterday, "If we look back forty years, we shall see that a great destructive work has been in operation among them, and the hand of death has obliterated many of the best known names. One of the forces which have been working against them is the tremendous change in the style of business consequent upon the development of railways and perfection of machinery, the rapid turning over of stocks, &c.; and those only have survived the new order of things that have had the foresight and energy to adapt themselves to the existing changes. As a matter of fact, the names of the large firms who have foreseen and met these changes can be counted upon the fingers of one hand. A similar weeding out process has been going on in the manufacturing trade. Take

the case of Bradford. Never perhaps has that enterprising town passed through a more sifting time than during the past few years, when a complete change of fashion, from the bright haired wools—which the Bradford manufacturer could manipulate at will—to the softer and rougher Cheviots, has been so marked. Those who have adapted their looms to the popular demand have survived, while many who have clung to the hope of a return of fashion to the lustre goods have been compelled to retire; if, indeed, they have not lost their all. In the manufacture of plain Bradford goods also, such as cashmeres, the stern law of the survival of the fittest has been very apparent, for the race has been against time, and the man of capital who could put down the newest and fastest machinery has done the trade to the exclusion, and ultimate extinction, of his poorer rival. This feature is very noticeable in the Huddersfield trade, where during the last twelve months some twenty small manufacturers have 'gone to the wall,' crowded out by firms with larger capital, who have put down machinery of the most modern construction, with running powers from 25 per cent. to 50 per cent. in excess of the old machines of twenty years ago."

It is the law of the survival of the fittest in the competition which your own merchants and manufacturers make among themselves. If your own manufacturers read your own newspapers, and gave serious thought to what they contain, including the changes recorded in them as taking place in other parts of the world, they would find great profit from so doing. The merchants and manufacturers in the United States are more alive to what is going on in the rest of the world, even to having samples sent him, from every manufacturing centre, of anything new which is produced, that he may buy it or copy it (if this is done) as the circumstances of the case make most profitable. So that your manufacturer who would remain away from the Chicago Exposition lest his exhibit be copied—as suggested by a member of the Liverpool Chamber of Commerce, as a reason for not co-operating with your Council—would only lose the benefit of showing his wares, while the American manufacturer would be exhibiting the reproduction of the very article which his less enterprising competitor had thought to keep from his envious and rapacious hand, if he were disposed to copy patterns, as has been freely stated; at the same time telling the visitor at his stall in the American Section, to whom Great Britain and the United States are both open as a source of supply, " If you wish anything different, no matter how divergent from our present output, describe it, and we will submit patterns until you say you are satisfied, and produce for you just what you want."

Nothing that I have said before about our becoming in time competitors with you in supplying the rest of the world with manufactured articles - especially cotton—bears in the immediate future upon our present relations of interchanging raw materials for finished product. For while our resources are such as to point to our becoming in time such competitors, we have too much else to do in the way of what might be called "opening up the country" to enter for the present vigorously upon that career which will be ours in due time. We are like the vanguard of a great army advancing into, and taking possession of, an unknown and uncultivated country, rich as the Promised Land in everything that can contribute to the wants of man, but requiring first that forests be cleared, houses built, crops planted, and allowance made for the harvest to follow, seed time according to the laws of nature, and hence requiring to be largely provisioned from a base of supplies such as you have been to us from the time the first colony landed upon the shores of Virginia, and barely kept soul and body together by begging corn from the rude savage found in possession of the land. For many years to come we will have to send you our corn now produced beyond our own requirements, the productions of which we have well nigh brought to its maximum, while in other things we are but upon the margin of our resources and capabilities. As your great enterprises—your manufactures and your shipping trade had small beginning, and grew year by year, correcting mistakes of inexperience, improving methods, cheapening the art of production, so must ours go through the several stages of imperfection until time, as it matures the boy into the man, brings them to their full stature. I must refer in the little time that is left to one other factor of no less importance in the trade relations of the future between Great Britain and the United States, and that is to our purchasing power, which is increasing by leaps and bounds, and the cultivation of the tastes of our people, increasing their wants in proportion to the ability to gratify them. I can see no better way to carry an idea of this point to your minds than by giving you a few statistics as to our internal com-

merce. The traffic upon our great lakes compared with your traffic on the sea, will give you a fair idea of the magnitude of this internal commerce. The tonnage of vessels entering and clearing at the port of Chicago, in 1890, was 8,774,096, while the tonnage of ships entering and clearing from the port of Liverpool was 9,329,720 tons. The tonnage of vessels that passed through the Detroit River was 21,288,472 tons, and that through the Sault St. Marie Canal 9,041,213, as compared with a tonnage of 6,723,187 tons through the Suez Canal. The tonnage at the port of Chicago doubled itself in the last census decade, and it is not unlikely that 1900 will show an increase in like ratio over 1890, for 53,411 miles of railway terminal at that port, and in a year move 43,000,000 tons of freight. In the central, northern, and north-western States,, the total freight moved was 196,000,000 tons; and this is without mentioning the traffic on 20,000 miles of navigable rivers in the United States. "In these great channels, the domestic exchanges represent an annual value, perhaps, twenty-five times as great as the total of exports and imports," Mr. Blaine, our Secretary of State, tells us in his work "Twenty Years in Congress." The River and Harbour Bill of the present Congress appropriates $21,000,000 for river and harbour improvements, $4,000,000 which is to be expended upon the Mississippi River between its mouth and St. Paul, and authorises the Secretary of War to make contracts for $12,000,000 more to be spent on the same work, to be expended in sums of $4,000,000 a year. Besides those expenditures, provision is made in another Bill for improvements in the harbour of Galveston, Texas. It is to the water-ways that we owe the cheap transportation which has contributed so much to our marvellous development. It is interesting to compare the present cost of transportation to that of seventy-five years ago. In 1817, it cost $140 to transport a ton of freight from Philadelphia to Pittsburgh, while in 1886, at the average rate received by the Pennsylvania Railroad for the carriage of freight, three-quarters of a cent per ton per mile, it cost $2·87. At the former time, the working man in Philadelphia had to pay $14 for moving a barrel of flour from Pittsburgh, against 28¢ now, and the Pittsburgh consumer paid $7 freight upon every 100 pounds of dry goods brought from Philadelphia, which 100 pounds is now hauled for 14¢. From this you can get some idea of the work to which I referred above as "opening up the country."

Behind this work we have an army of 65,000,000 people, honest, industrious, facile of brain and expert of hand, bold to plan and ingenious to execute, and it is not difficult to forecast the future of the United States in the ordinary course of events. But there is still room for men of the character who laid the foundation of our greatness, and who have contributed to its upbuilding. If changing conditions point to the United States as the place offering the best return not only for your capital which you have already largely invested there, but also for your ingenuity and labour, you will find a welcome for yourself as well as a place to invest your money with profit.

I have endeavoured, gentlemen, to lay before you as briefly as possible a *resumé* of your own commercial policy and the view taken of it by other nations, in order that, seeing the question from our standpoint, you might judge us fairly in the policy we are pursuing. I hope I have met with some success in this particular.

In the second part of my address I have endeavoured, in reviewing the present condition of trade between Great Britain and Ireland and the United States, to place before you in a strong light, the other causes which, independent of the McKinley Tariff, were at work before the passage of this Act to cause a shrinkage in trade which was rather checked than accelerated by the tariff. After this I have endeavoured to point out the probable future course of trade between the two countries with the causes, which, as I see them, will operate in the direction I indicate, and then I have shown, or endeavoured to show, that notwithstanding these causes, at this present time operating in a very limited degree, for reasons which I have also indicated, the exports of Great Britain to the United States must continue to be large, increasing for a time at least from year to year, and as it reaches its maximum you must expect to find us running you close in the markets of the world, foreign to both, for we will then be powerful competitors in other fields. In order that the thin end of wedge, which I have pointed out to you is entering the field foreign to both, may not be driven in a marked degree further into the mass known as markets, when the merchants from these markets assemble at Chicago in 1893, does it not behove your manufacturers to be up and doing in the preparation of the great

exhibit which you have the material to assemble in solid phalanx in the British Section. This Columbian Exposition is absolutely unique in that never before has a country whose chief exports are raw materials which it exchanges for finished products, invited those who compete with her merchants to bring their wares for display and sale. You buy no manufactured articles from us and yon do not come as possible purchasers. Heretofore exhibitions, beginning with your own in 1851, have been held under widely different circumstances, the nations holding not only an exhibition in the modern sense, but also a "fair" in the ancient sense, whither merchants flocked to buy the goods displayed. But in our invitation to you there is even more than this. We have invited you as our kinsmen, a people in whose veins flows the same blood, and through whose institutions ramify the same laws and customs; a people who, worshipping God in their own way, which is our way, allow others the privilege of worshipping Him according to the dictates of their own conscience, as do we, or even to deny his existence, and not lose caste, if sincere and honest in such belief. Ignoring the creeds, we both stand for reaching out a helping hand to struggling humanity—the poor and the unfortunate, wherever found—and not only extending our trade over the known world, but with it the mantle of religion and justice. Linking these two great objects together, we can meet on the field at Chicago, in 1893 as rivals, not only in trade, but also in elevating and purifying its methods, and in extending the benefit of Christian civilisation to the uttermost parts of the earth. There is enough for both to do, and for both to reap in profit and honour.

May a laudable competition such as this be the only contest which time will bring in its flight between the two great English-speaking nations; and in this hope we may exclaim, in the words of the gentleman and scholar, poet, and diplomatist, your late Ambassador to Paris:—

"Then blow, blow the clarion and let the war roll,
Strike steel upon steel, and strike soul upon soul,
If in striking you kindle keen flashes and bright
From the manhood in man stricken thus into light."

And to give expression to, and emphasise the relationship which every thinking man must feel should exist between these two members of one family, in the part which it is for them to play in the future history of the world, perhaps we in the United States may look forward to the pleasure of welcoming your President, his Royal Highness the Prince of Wales, or some other member of your Royal Family, to represent your gracious Queen, who is respected with us, and all over the world, as she is beloved by her own people.

DISCUSSION.

The CHAIRMAN said they were much indebted to Mr. McCormick for pointing out so clearly the advantages which would be gained from exhibits at Chicago. He had had the advantage of visiting the United States several times, and must say that at the Philadelphia Exhibition the English were received with great cordiality, though even then the protectionist policy, which had now culminated in the McKinley tariff, was beginning. He felt quite certain that until the protective tariff had produced such an excellence in American manufactures as put them on a level with ourselves, it was an advantage to us, as it prevented American competition in foreign markets. No doubt the day would come when their industries would be developed, as Mr. McCormick said ours had been by protection, and then England would have to make great efforts to hold her own. It was of the highest importance to Great Britain that her manufacturers should be well represented at Chicago, which would be the finest Exhibition ever held, and would attract people from all parts of the world, and he hoped Englishmen would recognise this and exert themselves accordingly. He believed the Government had recognised the importance of our having a good representation there, and there was every hope of a large increase in the grant made to the Royal Commission, so that exhibitors would not be called upon to pay for the space they occupied.

Mr. DREDGE complimented Mr. McCormick on the admirable way in which he had acquitted himself of a somewhat difficult and delicate task. He had given an interesting chapter from the commercial history of England, and had let Englishmen see themselves as other nations saw them, which was a wholesome lesson if properly applied. Free trade views were so ingrained in us that we were apt to be intolerant of those countries which preferred to hug their chains, and live in the darkness of protection; but so long as England thought it was her interest to maintain protection, she pushed both the theory and practice to the extreme limit, and maintained it, moreover, on the highest moral grounds. When, however, free trade was found more profitable, it was discovered that there was a still higher commercial philosophy, and protection was denounced as something very wicked. We had no right to take up that intolerant attitude; but on the

other hand, we ought to be thankful that in spite of the McKinley tariff, which prevented millions of American citizens from enjoying the benefits which British manufacturers were ready to shower upon them, the United States were still such good customers, and we ought to do our best to maintain and extend that trade. Next year our foreign trade with South America, with the Colonies, with China and Japan, would be open to attack by all the manufacturing countries that exhibited at Chicago, and it was no use for us to pose as the greatest manufacturing country in the world, if we did not make our position recognised by other countries, and we should undoubtedly be judged by the display we made on that occasion. Some months ago he called attention in that room to the wonderful organisation which, under the name of the Latin American Federation, was being worked with much success at Washington, its object being to destroy, as far as possible, British trade with the republics of South America, and divert it to the United States. Probably some success might be achieved in the course of time, but we need not fear any very serious competition for some years to come in that quarter. There was, however, another peril much nearer home, and more imminent. Germany had as much reason as ourselves to be dissatisfied with the McKinley tariff, but they were not hanging back on that account from the Exposition; on the contrary, there was great enthusiasm over it, thousands were applyfor space, and the Government was making a grant of £100,000. This was not done on merely sentimental grounds; the intention was to make the German Section something to be remembered, a venture which should bear a rich harvest at our expense. No doubt the ultimate object was to share in the South American trade, but the immediate intention was to overshadow the British Section, and to obtain as much as possible of the £30,000,000 of trade which we did with the United States. And this result would undoubtedly happen unless our manufacturers showed more energy.

Sir H. TRUEMAN WOOD said he did not propose to follow Mr. McCormick into the large questions he had raised, but was glad to have the opportunity of saying a word on that part of the paper which dealt with the Chicago Exhibition, with which the Society was so closely associated. The Council had certain advantages over other Royal Commissions, and certain special drawbacks. Amongst its advantages was that of having amongst them Mr. McCormick as special delegate from the United States, a Chicago man, and thoroughly in touch with the executive of the Exhibition, who was always ready to give any information and advice. Amongst the drawbacks, he might refer to the fact that the matter had to a certain extent been drawn into the arena of politics, though this had not been altogether a disadvantage. Originally, the Council undertook to do the work of the Section with a sum of £25,000; and he held they would have done so with fair success, but the question got into Parliament; and there was a unanimous opinion in all quarters that the country was not being properly represented; that it ought not to be compared with Paraguay or Japan, but that the Commission representing Great Britain should have sufficient means to carry out its work properly. He believed, therefore, that the Government intended to throw a greater burden on the shoulders of the Royal Commission, and they would brace themselves to bear up under it. At all former Exhibitions, the Commission was left to do its best, and was then judged by the results; but, on this occasion, questions were asked in Parliament as to what was being done; and a statement had been made that the number of exhibitors would compare very unfavourably with those from other countries. Of course, the number of those willing to pay for space, and of those willing to ask for it, if they could get it for nothing, and could throw it up at any time, were very different. But he had reason to believe that, even if no further applications were made, the British Section at Chicago would very fairly represent most of the industries of the country. Some of the departments would be sadly lacking, no doubt. There would be a poor show of machinery, and very little in the way of agricultural implements; but that was foreseen from the beginning; and, in some other branches, we should be represented as well as could be wished. A trade was better represented by two or three first-class houses than by 20 or 30 small manufacturers. For example, at the Paris Exhibition, Belgium had about 120,000 square feet and 1,400 exhibitors; whilst Britain had about 200,000 square feet, and 670 exhibitors, which simply meant that they showed on a much larger scale than their Belgian friends. The great number of Belgian exhibitors was made up by collective or joint exhibitors. They were told that in the present case there were 2,500 coming from Germany, but if they were all to be packed into the space allotted to Germany, they would not make very much show in comparison with their number. It did not follow, because there were few British exhibitors, that it would be an insignificant show. There would be an excellent show, and if exhibitors were relieved of the charge for space, they would be able to apply the money in embellishing and setting off their exhibits. The two great hindrances were the McKinley tariff, on which he did not propose to say anything further, and the fear that productions would be copied; but when manufacturers sent first-rate work he did not think they need fear copying. There were certain branches in which we were ahead of America, as there were some in which she had the advantage; and in these matters, copy as much as they would, they would not produce the same thing, and the American customer would, as a rule, buy the genuine article and not the imitation. It was no use scolding the British manufacturer because he did not see fit to exhibit at Chicago; the proper way to go to work

was to show him, as had been done in the paper, that it was to his advantage, and then he would do it fast enough. A certain amount of patriotic feeling might be relied on, and one exhibitor, whom he saw present, was making one of the finest exhibits in a certain class, to a great extent from purely patriotic motives, but the interest of his firm was also involved. He had urged on the representative of one of the largest engineering firms in the world that such a firm should not look on the matter merely as an advertisement, but that it was their duty to represent British engineering. He said they were ready to do that, and did not mind spending two or three thousand pounds upon exhibiting, but they were not prepared to lose ten or fifteen, and that was, he held, the general feeling. A word in conclusion on collective exhibits. The French, Germans, and Belgians were willing to combine together to represent the industry in which they were engaged, knowing that the result would be to bring orders to the country, not necessarily to the particular firm exhibiting. It was worth consideration by manufacturers whether they would not do well to sink their trade rivalries, and combine together to represent English industry in any particular department. The attempt was being made in some instances, by the Institute of British Carriage Manufactnrers for example, mainly at the instance of Mr. Hooper, and he hoped other trades would follow the example.

Mr. ROBERT DUNCAN said the Chicago Exhibition had adopted a very ambitious title—The World's Fair—and, of course, claimed to represent the trade and industry of the world. Many British manufacturers felt that if they went to such an Exhibition, it should only be when a policy had been adopted worthy of such an ambition, a policy which looked not merely to the interests of the nation holding the Exhibition, but endeavoured to obtain fair-play for everyone. That could only be done by working harmoniously together, not by each nation trying to get the better of their neighbours. If the British people were thoroughly convinced that the United States were trying to get the better of them in the markets of South America, China and Japan, they would naturally resent it. A splendid move had been made in the direction of a policy of harmony, by calling a Conference of representatives of Chambers of Commerce from all parts of the Empire, to meet in London this year, and he hoped the same policy might be pursued in America.

Mr. STEPHEN BOURNE thought they were indebted to Mr. McCormick, not only for his candour in pointing out how we were seen by others, but also for throwing considerable light on the motives which had actuated the Americans in introducing the McKinley Tariff, and adopting what seemed to us a most retrograde policy, such as we were foolish enough to indulge in 200 years ago. It was not entirely foolish, however, and there was one argument to be adduced in favour of protection. When a country possessed natural advantages which were certain to make it successful in any particular branch of manufacture, it was perfectly justified in fostering that industry until it was able to run alone. We did that with regard to patents, giving protection for a time to a man, to enable him to do that which he believed he would be able to to do ultimately without any protection at all. On the other hand, we had had such proof of the advantages of free trade that it was useless to expect Englishmen to go back to protection. We could not afford to do so; we lived by our export trade with other nations, and if we handicapped our exporters, and so made it more difficult and expensive for them to manufacture the goods in which they dealt, we might say good-bye to a large portion of our export trade. In one respect the McKinley tariff was an advantage to us, because America possessed such enormous natural advantages, that when once she adopted free trade she would run many of our manufacturers very hard indeed. Reference had been made to the decline in American shipping since iron had taken the place of wood, and so long as she enhanced the price of iron by the heavy duty imposed, so long would England maintain her superiority in that field of enterprise which yielded a large amount of her wealth. A comparison had been made between the tonnage going through the Detroit canal and Suez canal, and between that entering Chicago and Liverpool respectively; but such comparisons were illusory unless the tonnage were multiplied by the mileage it had been carried. He regretted that so much attention had been given to what was really a side issue—the Chicago Exhibition—though it was very useful to have had Sir Henry Wood's clear exposition of the matter. He was glad to hear that British manufacturers would be well represented, but it must be remembered that we started Exhibitions, and were, perhaps, beginning to get a little tired of them. He did not think Englishmen need be in much fear of being ruined by the Nicaraguan Canal, even when it had been successfully accomplished. New York would be no nearer Africa than it was now; and it was in that direction that our manufacturers must look for an extension of their trade. With such a large Colonial Empire, it was not altogether a bad thing to be driven to rely on our own resources instead of on foreigners, and we should then be independent of the protective policy of anyone.

Mr. OLIVER WILLIAMS asked if it was not understood that the Exhibition at Chicago would be equivalent to a bonded warehouse, so that the tariff would not affect goods merely sent for exhibition.

The CHAIRMAN said that was so.

Mr. HALSEY did not understand why the factory should go to the cotton field, as was suggested in the paper; why should it not go to the coal and iron, as it had done in England, and to the place where there was cheap labour.

The CHAIRMAN then proposed a vote of thanks to Mr. McCormick, which was carried unanimously.

Mr. McCORMICK, in acknowledging the compliment, said the cotton mills in England went to the coal and iron fields; and as enormous beds of coal and iron had recently been found in the South, it led him to think that the cotton mills would be established there also.

Correspondence.

SPONTANEOUS COMBUSTION OF COAL.

Mr. W. Cave Thomas advances the theory that pressure of the superincumbent mass is the chief factor in leading to the spontaneous ignition of coal. This idea is by no means new, and can easily be shown to be utterly fallacious. Supposing a cargo of coal to be 33 feet deep, and to be solid the weight carried by the lowest portion would be a little under 20 lbs. on the square inch; and if Mr. Thomas will take a lump of coal of a kind known to be liable to spontaneous ignition, and will bring ten times that pressure to bear upon it, he will find that any rise in temperature is so slight that he will have difficulty in recording it. If he will then powder the same coal and place it in a large square biscuit tin, and will keep it in the oven at a temperature of a little over 100° C. for some hours, he will find that the coal catches fire although no pressure is upon it. In masses of coal the ignition always take place at the bottom, because it is at this part that the maximum temperature is attained, as it is furthest away from the cooling action of the air, and is surrounded with the largest amount of non-conducting material.

VIVIAN B. LEWES.

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 12. — C. PURDON CLARKE, C.I.E., "English Brocades and Figured Silks." The LORD MASHAM will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

BENNETT H. BROUGH, Assoc.R.S.M., F.G.S., "Mine Surveying." Three Lectures.

LECTURE III.—APRIL 11. — *Levelling.* — The level and staff for underground use—Applications of levelling in mining operations—The Carrara marble railway—Aërial wire ropeways—Hydraulic mining ditches—The St. Gothard, Mont Cenis, and Croton aqueduct tunnels—The Ernst-August adit-level—Mapping bore-holes.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Bennet H. Brough, "Mine Surveying." (Lecture III.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Professor Stanfield, "Ore Concentration (New Dry Method);" illustrated by working model of machine, and lantern slides. 2. Dr. W. G. Black, "A Floating Rain Gauge and Evaporator for Ponds." 3. Mr. William Gray, "Heat."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1a, Adelphi-terrace, W.C., 8 p.m. Professor Geikie, "The Glacial Period."

TUESDAY, APRIL 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. C. Purdon Clarke, "English Brocades and Figured Silks."

Royal Institution, Albemarle-street, W., 3 p.m.

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. H. Alfred Roechling's paper, "The Sewage-Farms of Berlin."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Colonial Institute, Whitehall Rooms, Hotel Metropole, Whitehall-place, S.W., 8 p.m. Mr. E. A. Maund, "Mashonaland, and its Development."

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, APRIL 13...Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. J. Traill Taylor, "The Choice of Lenses."

Civil and Mechanical Engineers, 12, Delahay-street, S.W., 7 p.m. Mr. G. Macdonnel Lemmi, "Remarks on the Development of Ordnance."

THURSDAY, APRIL 14...Institute of Architecture, Science, and Art, Dundee, 8 p.m. Mr. W. D. M'Kay, "The Art of the Low Countries."

Mathematical, 22, Albemarle-street, W., 8 p.m.

CORRECTION.—In the Obituary notice of the late Sir Francis Charles Knowles, Bart., F.R.S., in the last number of the *Journal* (p. 509), the name was unfortunately misprinted as "Knollys."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,056. Vol. XL.

FRIDAY, APRIL 15, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 11th inst., Mr. BENNETT H. BROUGH, Assoc.R.S.M., F.G.S., delivered the third and last lecture of the course on "Mine Surveying."

On the motion of the CHAIRMAN (Professor W. C. Roberts-Austen, C.B., F.R.S.), the thanks of the meeting were voted to Mr. Brough for his interesting course of lectures.

The lectures will be printed in the *Journal* during the autumn recess.

Chicago Exhibition, 1893.

The Royal Commission have received information that Her Majesty's Government have it in contemplation to increase the grant of £25,000 made for the purposes of the British Section, in order that the charges for space may be remitted. As soon as they receive information of the final decision of the Government on this point, they will communicate immediately to the exhibitors, and will arrange for the payments already received to be returned.

PUBLIC MEETING AT MANCHESTER.

A meeting of manufacturers, merchants, and others interested in the Exhibition was held on Friday afternoon, 8th inst., at the Manchester Town Hall.

The MAYOR (Mr. Alderman Leech) who presided said that considering the importance of the Exhibition, he readily consented to the wish expressed by the Royal Commission that he should call a public meeting to consider the matter. The Exhibition would be on perhaps a larger scale than any yet held, and the inhabitants of Chicago had themselves formed a guarantee fund of £2,000,000 sterling in order to ensure its success. The English Government had voted £25,000 to assist the representation of this country at the Exhibition, but it was believed that this sum would be increased to £60,000. No doubt there was some soreness in this country with regard to the M'Kinley Tariff; but other countries had to submit to the same regulations, and France and Germany were making great efforts to be thoroughly represented.

Sir DOUGLAS GALTON, K.C.B., said he and his fellow Commissioners had come down here because they felt the enormous importance of having England properly represented at the Chicago Exhibition. He might be met by remarks as to the McKinley tariff, but it was his very strong opinion that our manufactnrers benefited by the protection which existed in America. If the Americans had not had protection for their manufactures and industries, they would now be competing with us more than any other nation, in every market in the world, and probably, with their wonderful skill and talent, would be beating us. It was not so much for the sale of our goods in the United States that we ought to exhibit at this Exhibition. The Exhibition would not only represent the United States, but would be an exhibition on the part of all nations in the world. The South American Republics, with which we had a large trade, would be fully represented. There would be China and Japan, and also other nations to whom we now send goods. There would, in addition, be a strong representation of the industries of Germany and France. The Government were extremely desirous that England should be thoroughly represented, and for that reason they were now considering the question of increasing the amount to be devoted to this purpose from £25,000 to £60,000. The increase in the grant would enable them to offer space to the exhibitors free of charge. The Royal Commission earnestly hoped that the various great industrial centres of England would take up this question, and organise exhibits of their various industries.

Mr. R. M'CORMICK, the Commissioner from Chicago, said it gave him great pleasure to be in Manchester. In America, Manchester was regarded as the Chicago of Great Britain. There was, however, a marked difference between the two places. Manchester was the centre of a great manufacturing district, and Chicago was the centre of a great agricultural district. The population of each place was about 1,000,000, and, like Manchester, Chicago was about to make a canal which would save the transshipment of goods. He did not propose to discuss the M'Kinley Tariff, but he would like to point out that, notwithstanding that tariff, the United States were still by far our best customers. Chicago, moreover, was the centre of a large district where there had been a great deal of opposition to the tariff. By sending goods to the Exhibition, English manufacturers would be able to demonstrate to the merchants

and agriculturists of the Great West how much cheaper they could sell their goods without the tariff. Exhibitors would be allowed to mark on their goods the cost to the buyer at Chicago without the tariff, and the cost with the tariff. This would be a practical demonstration of the benefit there would be in doing away with the tariff. The Chicago Exhibition would be absolutely unique. Hitherto exhibitions had been held in countries which were not only large manufacturers but large exporters of manufactured goods. The United States, on the other hand, did not export manufactured goods, or at any rate not in large quantities. It exported raw materials, and principally to this country, taking back from us manufactured goods. Efforts were about to be made in the United States to secure a share of the cotton trade with South America, which had hitherto been controlled by Great Britain.

Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., said Manchester was always first in every good work, and he was sure the Manchester manufacturers would take a prominent part in this exhibition. It would be no ordinary exhibition. It would not be an exhibition for purposes of amusement, like that at Paris. It would be an exhibition for business men and intended for business purposes. He hoped England would make a good exhibit, and show what the old country could do. It would be a great mistake if we did not offer the right hand of fellowship to the United States on this occasion. It would, moreover, be very important to show the American people the prices at which our goods could be manufactured, and what it cost them to have a tariff.

Sir H. TRUEMAN WOOD said the arrangements were so far completed that, even if no further progress was made with the British section, England would have no reason to be ashamed of her show there. The greater portion of the space placed at the disposal of the Royal Commission was already occupied, and he hoped Manchester would come forward.

Mr. Alderman BAILEY said he did not know a single engineer in this district who proposed to be an exhibitor, and he was not at all surprised. The Americans had already copied our machinery to a great extent, and why should we, at our own cost, give them further facilities to do so.

Mr. MCCORMICK, in answer to Mr. E. Sowerbutts, said that steps would be taken to protect, while it was in America, any article which was patented here, but not in that country. He further remarked that the English manufacturers could not please their brethren in America better than by staying away. The Americans were beginning to be exporters of iron goods, and it would quite suit them if that class of goods was not represented from this country.

The MAYOR OF OLDHAM (Mr. Alderman Emmott) said the makers of machinery in England did most of their business, he believed, with foreign countries; and, as they sometimes complained that their goods were not known, he did not see why they should object to the advertisement they would get at Chicago.

Votes of thanks to the Royal Commissioners and to Mr. McCormick were passed.

APPLICATIONS FOR SPACE IN THE BRITISH SECTION.

Intending exhibitors are reminded that applications for space must be made immediately, as the allotment of space is now proceeding. Most of the available space is now occupied, and no time should therefore be lost by manufacturers desiring to be represented.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 5th, 1892; Sir CHARLES TUPPER, G.C.M.G., C.B., in the chair.

The paper read was—

THE RED AND WHITE RACES IN MANITOBA AND THE NORTH-WEST.

BY THE REV. JOHN MACLEAN, D.D.

To the West! is the inspiring cry of the young hearts of the Old World. The development of the western world is the answer to this joyous shout of young Britain. The tide of conquest is flowing toward the majestic mountains of Greater Canada, and to-day the songs of love and labour may be heard upon the prairies and upon the hills of the fairest land, whose dwellers reverently uncover their heads as they gaze upon the unfurled flag of a thousand battles.

When I travelled westward, in the spring of 1880, under the impulse of duty, the prairies resounded with the tread of tens of thousands of buffalo. Courageous would that man be who would dare to tell to a British

audience the numbers in the vast herds of buffalo which he has seen in the early years on the western plains. The possibility of grasping the immensity of numbers may be helped by the assurance that, when we visited that wondrous land for four successive years, as we journeyed for hundreds of miles, the camp fires were made of the excrement of these animals, and this lay in such abundance, that, within an area of fifty yards, sufficient was obtained for all the necessary purposes of fire for cooking.

The barn-yards and pasture fields of England do not offer such evidence of the presence of cattle as we saw for hundreds of miles all over the country. I have not the note books with me containing the exact statistics showing the expenditure of money in the purchase of bones in the Moosejaw district, during a period of five years, but convincing evidence can be given to prove that, within an area of fifty miles, several hundred thousand of these animals have died. Eastward they roamed for several hundred miles, and westward for five hundred, while, southward and northward, the range of the buffalo must be reckoned by more than a thousand miles. What will be the destiny of a land of such abounding fruitfulness, in sustaining countless numbers of animals, whose life and death have prepared the soil for the millions of men and women who shall ultimately claim these fertile acres as an undying heritage for posterity? The red men of the West, undaunted, rode over the boundless plains in quest of food. Men of daring—members of the white race—greedy of gain, and delighting in adventnre, sought out the hardy children of the wilderness, and henceforth an increased value was placed upon the hides of the buffalo. Liquor was introduced, and debauchery speedily followed. Missionaries and loyal-hearted citizens interposed, and, in answer to their petitions, the Canadian Government sent forth, in the year 1874, the North-West Mounted Police. Faithful in the discharge of their duties, these men won the hearts of the Indians, destroyed the influence of the *régime* of the whiskey-traders; but it was too late to save the buffaloes, for they fell before advancing civilisation, and in its interests, so that the countless herds have gone to return no more. The buffaloes were slain, the Indians became destitute, and civilisation advanced. Had they remained, the native culture of the red men would not have rapidly died away. The Union Jack and the red-coats of the mounted police are respected by the Indians, as they represent just treatment, the power of liberty and protection on the throne and behind it. They speak gravely in their lodges of these matters, and the Great Mother is synonymous with justice, peace, and strength. Unbroken treaties are the consequence of this unity of sentiment among the Canadian Indians, and not a single Indian war degrades the annals of our glory. The laws of England are, to them, a strong bulwark, and if the Great Mother has issued a decree, fearlessly will they defend the honour and glory of the Empire.

There exists amongst the native tribes a distinctive civilisation, differing greatly from the culture of the white race, yet nevertheless true. It is a civilisation of nature, not a culture derived from books. Cruel savages they are not, and there are not any peoples more devoted to their religious rites than are these men, as shown by their belief in prayer, the duty of sacrifice, the existence of Deity, the immortality of the soul, and the knowledge of a future state. The sun dance, sweat-lodge, and gifts to the great sun reveal the piety of these prairie heroes. Traditions of creation, the origin of man, the flood, the advent of a teacher for the race, are numerous. Polygamy, as a consequence of war, is rapidly passing away before nature's wise law, which makes provision for the equality of the sexes. A strong, accurate, euphonious, and expansive language exists, which reveals the wisdom and strength inherent in the intellectual life of these men.

In the interests of civilisation, to maintain peace between the red and white races, and to begin a course of training among the Indians, it became necessary to select tracts of land for distinctive occupation of the natives, which are called "reservations." These reservations have invariably been granted to the natives after they have selected them, a worthy act on the part of the Government. Peaceable and contented, the people have dwelt upon these beautiful tracts of land. The reservations are well watered, partly wooded, and the soil and pasture is excellent. The departure of the buffalo predicted utter destitution and death, but the authorities were not slow to supply the wants of the starving people, and a system of feeding was instituted, which has been continued in a modified manner upon some of the reserves until the present time. The reserves and people have been placed under the care of agents and officials who belong to the Indian Department. One of the principal objects of

the Indian Department has been to teach the people farming. Success has attended the labours of the agents and farming instructors. The average reader or traveller, ignorant of the principles of ethnology or sociology, makes serious mistakes in judging the results of all the expenditure of money and men, and in believing that the demands made for the outlay are unjust. Before the advent of the white men, the Indian was a hunter. He toiled hard to support his family, and was oftentimes absent for weeks, seeking to procure the necessaries of life for his family. When he returned, hungry and tired, from his hunting expedition, he threw down the produce of the chase, which was claimed by his wife. The few days spent at home in the camp were used in gathering strength for future toil. The wood and water for the household were procured by his wife; and the small patch of ground, which represented the interests of agriculture, was carefully tended by the female portion of the house. Hunting was a manly occupation, and agriculture was a trade which belonged to the women. So strongly imbedded were these divisions of labour in the minds of the people, that no one was bold enough to defy them; and there were not found men and women in the tribes who dared to subject themselves to the jeers of their fellows, by choosing the trade which belonged to the other sex. When, in the early years, I requested a Blackfoot Indian to saw some wood, I received the reply, "I will bring my wives to saw the wood." Requesting another to carry some water, he said, "Do you think I am a woman?" If white men and women recognise the division of labour among the sexes, and will not interfere with the occupations of each other, how can we expect the natives to break through the customs of the camps? Missionary labour, political and religious, has aimed at the overthrow of these distinctions, but this cannot be done within a few years. Many centuries have passed by since our ancestors rode along the banks of the rivers, securing pasturage for their cattle, wandering over vast expanses of country, unsettled, contentious and savage. The civilised man of the 19th century is not the product of a few decades, but of centuries. Surely it is unscientific to ask for an ideal white man to be evolved from the members of the red race within a few years. We cannot compare the races, but we may contrast them. There is a culture of the red race as there exists a civilisation of the white race. If there is to be a grafting of the old world customs of the natives of the new, there will be failure. The exaltation of the red man will become a reality through the destruction of the native customs, and this can be done through a gradual undermining of the life and thought of the dwellers in the camps upon the plains.

The thorough acceptance of the modes of life and thinking of the white race by the natives, must be the work of many, very many years, and unjust is that man who demands results within two or three decades, or condemns men and methods, because the people do not speedily conform to the ideas of the critic.

The Indian schools upon the reservations are slowly changing the traditions, customs, and language of the people. Not fully have the natives grasped the ideas inherent in our systems of education. So antagonistic are our methods, and so subtle our principles, that the men who are ever living for the present fail to appreciate the benefits which lie so far distant. If it can be shown that by means of education the men will become better hunters, and the women tan the skins and make mocassins better than in former years, eagerly will they grasp at this kind of knowledge. Slowly but surely will education win its way into the hearts and homes of the red men, uniting them in one common interest. Industrial schools have been established with the noble aim of uplifting the children of the natives of the west. The wise treatment of the red men by the authorities has maintained peace, and made it possible among a warlike people to introduce the arts of civilisation, build railroads, villages, and towns, and further the interests of emigration. The settler's hut and the miner's shanty remain in peace, unmolested, and the inhabitants have no dread of danger, for there is none. Our mothers and daughters welcome the natives, and purchase game or wild fruits, or help them with a pittance from their small stores of goods.

European civilisation has sounded the war-cry of destiny in the overthrow of all the native tribes. Step by step, as the white man advances, the red man retreats, or bows his head and dies. Not so much through the introduction of disease—although this is fatal—as by the more powerful factor in civilisation, the limitation of freedom, is the destruction of the native races effected. These people fade away, as the story of statistics invariably tells us. The Blue-books show a maintenance of strength in numbers, but it is

the strength which is undermined. Decrease by absorption is the law. In tribes far removed from the haunts of the white man, there is progression in numbers, but, so soon as the white race appears, there begins declension. This is an unwritten law, which we may retard in its work, but which we cannot defeat. No man loves freedom so intensely as the dwellers on the prairies. He roams at will across the plains, monarch of all his eye surveys: the countless herds of buffaloes he claims for his possessions, and he owns no man as lord and master. The advent of the white man is conquest, and the heroes of the plains are destined to occupy an inferior position. Frequently do we see the aged man slowly wending his weary way to the camp, with his hand upon his mouth, singing the song of the shadow. If we accost him, to ask the cause of his sorrow, with a wave of his hand, after a sign of recognition, he will point to the prairies, and recount the years when the buffalo roamed in tens of thousands, the warriors were numerous, and the lands were his property, but now the towns of the white men are there, the fences express the claim of the pale-face, and cattle have replaced the bison. "Gone! they are all gone!" he sighs, and he departs to his lodge to die a broken-hearted man. Not by ill-treatment are the natives decreasing, but they have been conquered, and their ultimate destiny is extinction through death, and absorption by the white race.

Greater Canada, from the eastern boundary of Manitoba to the western limit of Alberta, and from the International boundary to the North Pole, is a vast expanse of territory, larger than the combined land areas of the following countries:—England, Scotland, Ireland, Wales, France, Spain, Portugal, Italy, Norway, Sweden, the German Empire, Japan, and China, exclusive of her dependencies. These countries have a united population of 600,000,000, and if Greater Canada is larger, making allowance for cold and inequalities of soil, surely there could be maintained at least one-half, or a combined population of 300,000,000. This is only a small portion of our dominion. Winnipeg occupies a central position between the Atlantic and Pacific, and the centres of population must travel westward towards the mountains and prairies, and the golden sea.

In such a vast country the soil is of various qualities, adapted for every kind of grain and fruit. In the Dominion, there exists every kind of climate, from the soft breezes of Southern Alberta and British Columbia to the intense cold of the Arctic regions. The winters of Manitoba differ from those of Assiniboia, Alberta, and Saskatchewan. The invigorating winter of Manitoba is productive of health and manhood. Enterprising men and women in quest of health and comfort prefer the cold of Manitoba to the damp temperate breezes of more southern climes. So vast is the Canadian North-West, that the settler can choose any kind of soil (prairie land or forest, with water or hay lands suitable for grazing or farming), and varieties of climate can there be found. The air is rare, and the cold weather does not produce that raw feeling which belongs to moist climes. It is invigorating, giving that bracing sensation which is the delight of young manhood. The Chinook winds of Alberta and Assiniboia cause the ice in the rivers to break up several times during the winter, and the snow upon the prairies departs at the presence of this warm wind. I have listened to the *sough* of this western wind in the mountains, and gazed upon the mist rising, indicating the coming of the wind. So soon as it comes, the cattle in the villages and *coulees* speedily seek the prairies, as the Indians leave their shelter in the bush. It is this delightful breeze which has given Alberta and Assiniboia the fame of the Range country, where roam the countless herds of wild cattle and horses, unhoused and unfed, yet fatter and sleeker after the severity of the winter than the best stall-fed cattle of eastern lands.

The coalfields of the North-West are very wide. Along the rivers the coal crops out in seams, varying from four feet to ten and twelve feet in thickness. Bituminous and anthracite coal, of excellent quality, is found in abundance, from the St. Mary's River, in Southern Alberta, to Edmonton, in Northern Alberta, and, from the coalfields of Manitoba, to Banff, in the Rocky Mountains. The coal mines at Lethbridge and Anthracite are sufficient proof of the wealth and possibilities of this industry. Pottery-clay, of good quality, and minerals of various kinds are to be found throughout the territories, and not far distant from the line of railroad. Timber is abundant in the district of Saskatchewan and the northern and western portions of Alberta.

So soon as the immigrant enters Manitoba or the North-West, he receives from the Government a homestead of 160 acres, upon which he performs the settlers' duties for three years, when it becomes his sole property. The

soil is productive, and the yield of grain abundant. There are good and bad sections in every district, as we find such in every country. Failures there will be, if men lack common sense and energy. The same contingencies apply to farming in Canada as in other lands, gold and silver pieces are not strewn upon the surface of the prairie, but they lie imbedded in the soil, and the plough will bring them forth. New lands require new and improved methods of farming, and the men who can adapt themselves to the country will soon reach positions of comfort, and enjoy a social status which they cannot attain within the same period in the Old World. The wheat fields of Manitoba and the North-West are eminently productive, when the settlers expend the labour necessary for proper fertilisation. The railroad cars which annually are sent to Ontario filled with the specimen products of the field and garden from the districts of Calgary, Regina, Brandon, and Winnipeg, astonish the people who dwell in Eastern Canada, giving rise to the belief that these exhibits are forced. Such, however, is not the case. Very fine garden produce has been exhibited, and as an evidence of what can be done, there have been shown cabbages, grown at Qu'Appelle and Edmonton, two widely separated districts, the diameter of which was 2½ feet, and the solid head 1½ feet.

In the Range country the buffalo roamed in thousands, and when the herds were destroyed, civilised man introduced domestic cattle. The grasses of the ranching districts are very nutritious, insomuch that when travelling in the early years in Southern Alberta, we fed our horses solely on the buffalo grass, popularly termed "bunch grass." One of my friends now resident at Lethbridge, within an area of 100 yards square at the foot of the Rocky Mountains, gathered in the spring specimens of 100 varieties of flowers. Cattle and horses, sheep and hogs, can be bred with little expense, save that which is incurred in labour. In such a country we seem to be lost through lack of men and money to develop its resources. Here is a field for the development of industries. Tanneries, woollen factories, cheese and butter factories, and various other branches of industry, can be carried on successfully, and yet we are without these, except in rare instances.

The settlers in Manitoba and the North-West are sober and industrious; and so soon as the first difficulties of settlement are overcome, schools and churches are begun. Nine years have not passed by since the first school was started in the Canadian North-West, and at the present time there are over 250 schools scattered over the territories. Education is free and compulsory. There are public and grammar or high schools; the headmasters of the latter must be graduates in arts of a British or Canadian university. The effects of our educational system are seen in a sturdy manhood and an industrious people. In the log-shanty of the settler oftentimes we meet graduates of Oxford and Cambridge and young men who have been trained in the universities of Glasgow, Edinburgh, and Dublin. Sometimes we are entertained in the settler's home by lady graduates of our colleges, and gracefully they perform their domestic duties, although bereft of the blessings of civilised life. Culture and manual labour are companions on the prairie.

The growth of our cities is rapid and stable. Winnipeg and Calgary are notable instances of speedy and permanent development. Unhampered by the vested interests of old trades and professions, the most modern appliances of art and science are sought and used in the development of industry. Thus we have in Winnipeg, Brandon, Regina, Moosejaw, and Calgary the electric light and telephone. In the three last-mentioned places there never was any gas, hence the transition was easy from the oil lamp to the electric light. Portage La Prairie, Moosomin, Prince Albert, Medicine Hat, Lethbridge, and Edmonton have developed rapidly, and numerous towns and villages are springing up as the settlers advance. Twelve years progress marks the beginning and growth of villages and towns in Manitoba and the North-West.

Since the building of the Canadian Pacific Railroad, the country has been studied as it never was before; and settlers from many lands have found their way towards the prairies and mountains of that western land. The construction of this railroad was attended with an almost absence of crime, owing to the prohibition of liquor and to the executive ability displayed in its management.

Representatives of the leading religious denominations are to be found toiling nobly upon the Indian reservations and among the settlers. Harmoniously they toil for the uplifting of the people, and the strengthening of the bonds of patriotism and religion.

The future of Manitoba and the North-West will depend largely upon the classes of settlers introduced. The tourist will find in the mountains scenery unexcelled, vigour and pleasure

in the National-park at Banff, with its hot springs of Continental fame. In the harvest time, upon the prairies, he will gaze enraptured upon the wheat-fields of the west, and, under the shadow of the Rockies, the herds of cattle and horses will reveal a new industry, destined to assume gigantic proportions at no distant date. We have faith in our country and the people. Let doubting ones come to our western land, and they will return with knowledge increased, and love begotten for the fairest colony of the British Empire.

DISCUSSION.

Mr. C. M. KENNEDY, C.B., said in the first place he wished to thank his friend Sir Charles Tupper for taking the chair that evening. In him they recognised a statesman who had rendered great services to the best interest of the Empire—who, at home, took a leading part in the formation of the Dominion—a most important event in colonial history; and who, as High Commissioner in London, had on every occasion sought to unite and strengthen the interests of the mother country and the colonies. They were glad to have him present that evening, and hoped to see him amongst them on many future occasions. As regards the very interesting paper to which they had listened, they had to consider the topics brought before them from many points of view. They possessed the great interest which a narrative of personal experience and work well performed always possessed, and opened out questions which bore on some of the most interesting problems of the history of the human race. They were particularly appropriate to us at the present time, as the Society was charged with responsible duties in connection with the forthcoming Exhibition in America. It is now four centuries since what was termed, in those days, "the great news" spread over Europe that European navigators had found, far off in what was then termed the region of the setting sun, islands rich in treasures, lying, as it was thought, off the coast of India and Cathay. The land which Dr. Maclean had described was a veritable land of promise to emigrants; and if, in present circumstances, men had to leave the old country, in British North America, they would not find themselves strangers; they would find there a land of free institutions, and would remain under the flag of the old country. They would not be misled and preyed upon as emigrants often were who went to alien shores. He thought the paper would be a valuable contribution to the *Journal*, and hoped the information contained in it would thus become widely known.

The CHAIRMAN said he was quite prepared to expect an interesting statement from Dr. Maclean, knowing that he had an opportunity of spending several years among the Indians of Manitoba, and the North-West, so that he was quite certain he would bring to our instruction a great deal of insight into the habits and manners of that people, but he confessed he was hardly prepared to learn that the art of scalping was an evidence of a high form of civilisation. He quite agreed with Dr. Maclean in regarding it as a very *capital* illustration of civilisation, and there was no doubt at all that a great moral underlies the statement that he had made in that respect, and that was that in order to judge, especially a savage people, or those who were called a savage people, people with manners and customs unlike our own, it was necessary to put oneself as far as possible in their place, and to look at this action from the standpoint which they occupied, and not from that occupied by a different people. He was quite prepared to confirm the statement as to the loyalty of the Indians in Canada to the Queen. It appeared from the most interesting book of Milton and Cheadle that the then savage tribes of Rupert's Land had a marked respect for her Majesty the Queen, and evinced on all occasions the greatest possible loyalty. He had himself had an opportunity of seeing something of that in his first visit to Fort Garry, or Winnipeg as it was then called, about 22 years ago. Manitoba was then in the occupation of Riel, who had incited a rebellion and induced the French half breeds to join with him. The communication with the north-west territory was stopped by Riel, but he (the Chairman) had occasion to pay him a visit. Having to adopt the custom of sleeping in the open air with the thermometer 30° below zero, he was able to bear testimony to the fact that, having travelled no less than 400 miles going and returning in that way, this occasioned no discomfort, and he never knew what it was to be cold, except on one night when a snow storm obliged them to put up the tent. In the journey from Fort Breckonbridge to the boundaries of the north-west territory, a distance of some 200 miles, he only came across one house, namely, at York-town, which was about half-way. The line he travelled from Fort Breckonbridge to the boundary of Canada, 200 miles, was the scene of the Sioux massacre of 1862, when the Sioux Indians rose in revolt against the United States authority, and burned every house to the ground, slaughtering the inhabitants for the entire distance. The single house to which he had referred, was that of the Hudson Bay Company, in which he spent the night, and the person who was in charge of the post at the time of the massacre, and his wife, remained in perfect safety in consequence of putting a little Hudson Bay Company's flag over it. When the Indians came to it, bringing fire and slaughter in their track, they said, "That is the queen," and they allowed the man and his wife to remain in perfect safety. He mentioned that as an illustration, and took the opportunity of saying that that was largely owing to the fact that the Hudson Bay Company, who then had under their control the whole of the great Rupert's Land, had adopted a policy of fairness and justice to the Indians which inspired them with

respect and confidence in the flag of England. The same thing was illustrated in a most striking manner from 1872 to 1876, when the boundary was being surveyed from the lake of the woods to the foot of the Rocky Mountains, a distance of 600 miles between the United States and the north-west territory of Canada. This work was performed by a joint Commission, one formed by the United States of America, and the other by the British Government. The gentleman in charge of the survey, her Majesty's Commissioner, required the assistance and support of no person except the staff and the necessary people to provide for the work and sustenance of the party, while the American Commissioner alongside of him in the same country had an army at his back, and could not advance a mile without the presence of a large force of United States troops. The only danger that any of the British party ever encountered was when he purchased a hat or a pair of boots of American construction, and strayed away from the party, being thus liable to be mistaken for a citizen of the United States. As Dr. Maclean had shown, this matter was all now changed by the advancing civilisation of the Indian; all the dangers that were undergone with these then considered savage tribes—and judged by our standpoint they had a great many of the traits of savage life—were changed by the advance of civilisation. He was glad to take this opportunity of bearing testimony to the deep obligation that was due to those missionaries of the cross, the clergymen of the Roman Catholic and of the Protestant churches who, in the earliest history of that country, long before the commencement of its occupation by civilised parties at all, had devoted with unstinted labour and toil their lives and services to civilise the Indians. Readers of those charming histories that Parkman had given of Indian life both in Canada and in the north-western and northern States would bear out the fact of the devoted labourers and missionaries who had spent the whole of their lives in Christianising Indians. He was glad to hear Dr. Maclean bear testimony to the manner in which the Government of Canada had treated the Indians since they came into possession of the country. There was not a foot of ground in Canada which had been obtained from the tribes except by a fair and honest bargain, and the treaties down to the present hour were religiously carried out. The soil had been handed over by the Indians upon terms which they considered satisfactory. Dr. Maclean had spoken of the spots that were reserved for the Indians, but he thought if the sizes of these spots had been given, one would have been greatly astounded. Manitoba and the north-west territory was a splendid wheat-growing district, and it was the best part of the country which had been reserved for the Indians. Now that game had been driven away, the Government of Canada were providing the means of living for the Indians; schools were erected for the children, and the Indians were not only cultivating their land, but at the Agricultural Shows prizes were not infrequently awarded to the Indians in competition with the agriculturists of the country. Many of the Indians were now living in comfortable houses, and adopted, to a large extent, the dress of civilisation. They were making in every respect a steady and most satisfactory advance in reference to the acquisition of those manners and habits which their changed position rendered necessary. The inhabitants of British Columbia were more responsive to the efforts of civilisation than those in other parts. The reason for this was that they had been less devoted to the chase than the plain Indians. It appeared from one of the latest Royal Gazettes which he received, that a proclamation had been issued providing for the enfranchisement of the Indians. The natives had always been treated as minors—as persons for whom the State should act as trustees in the preservation of property, but such was the advance of civilisation that in Ontario it had been found practicable to place them on a much higher level. The same arrangements were now being made in British Columbia, which was entirely owing to the steady advance of civilisation. In conclusion he proposed a hearty vote of thanks to Dr. Maclean for his instructive and interesting paper.

Dr. MACLEAN, in acknowledging the vote, said the size of a reserve spot was very often 100 miles long by 40 miles wide.

INDIAN SECTION.

Thursday, April 7, 1892; Sir JOHN STRACHEY, G.C.S.I., in the chair.

The paper read was—

THE AGRICULTURAL NEEDS OF INDIA.

By DR. J. AUGUSTUS VOELCKER.

To all who have any acquaintance with India, the recurrence of discussions upon the agricultural improvement of that vast empire will not appear more frequent than the importance of the subject demands. The Society of Arts, through its Indian Section, is always ready to avail itself of an opportunity which presents of regarding this question from the most recent point of view, and hence, I take it, I have been asked to bring before the Section, in brief review, the main conclusions formed during my late inquiry into the conditions of Indian agriculture. I may be allowed to consider myself as the third of the successive "inquirers" who, in recent times, have gone out from England to India with this special object, and as the second of those who have been specially deputed by the Council of India.

The first was the late Sir James Caird, whose great services to agriculture we all sincerely acknowledge, and whose loss we all regret. To myself it is a special sorrow that we have not Sir James Caird with us; for not only was it through my selection by him that I was privileged to go to India, but he had also most kindly promised to occupy the chair on the present occasion. I congratulate myself, however, on having the vacant place filled by one who has so deeply interested himself in Indian agriculture as Sir John Strachey has, and who, when in India, did so much towards its improvement.

The second visitor was Professor Wallace, of Edinburgh, who, with the eagerness and activity for which he is distinguished, went out on his own account to inform himself upon the agricultural conditions of India.

The third was myself, charged, like Sir James Caird, with an official mission. Of the special power which the bright intellect and the authoritative weight of experience possessed by Sir James Caird brought to bear upon the subject, I need not remind you; while Prof. Wallace, as a practical agriculturist and teacher, is well known to you also. It was left for me, however, to take up the inquiry from the point of the scientific inquirer rather than of the agricultural, economical, or practical farmer. Hence it is that my treatment of the subject will be somewhat different from that of my predecessors, and different, too, from that of others who have read similar papers before this Society. If, therefore, I confine myself more to the strictly *agricultural* needs, and deal less with such great questions as those of the relations of the State to the cultivators, or of the economical conditions of the country, you will take it that I do so because I feel myself but little qualified to treat of the latter. Again, it will be my object, not to describe what I saw of the agriculture, but to keep myself to such matters as indicate the existence of agricultural *needs* for which a remedy may, I consider, be found. The recurrence, within the last few months, of a time of widespread scarcity, not to say famine, has brought into special prominence the need of turning renewed and serious attention to the agricultural requirements of India, whereby the country may be enabled to provide for the rapid increase of population shown in the recent census returns. The indignation—often only too well justified—of Anglo-Indians of experience, against the *ipse dixits* of "specialists" who go out to India for a few months in the cold season, and then return with ready but impracticable suggestions for improvement of the country's government, trade, institutions, or agriculture, or all of them together, makes me hesitate when entering on the same path. Fortified, however, with the knowledge that I spent over a year upon my inquiry, and that I passed a "hot season" there as well as a "rainy" and a "cold" one, I approach my subject in the honest attempt, while suggesting lines of improvement, to do, nevertheless, no injustice to individuals for whom I have a very high esteem, and who have borne the heat and burden of many a long day in the service of their country, and taken part in the wonderfully able administration of our Indian Empire.

By way of explanation of my presence in India, let me say that the primary reason of my visit was the repeated applications of the Government of India to the Secretary of State to send out to them an agricultural chemist, and to enable them to complete the scheme which had been drawn up by the Imperial Land Revenue and Agricultural Department, with the view of meeting the obligations imposed upon them by the Famine Commissioners of 1879. Into the desirability of this proposal I was instructed to inquire.

Leaving England towards the close of November, 1889, I was absent over 14 months, spending just 13 months in India itself. Excluding Burma and Assam, I visited each of the provinces in two different seasons, and I may fairly say that the greater part of my time was spent in going about the country, with the view of seeing as much as I could of its agriculture. Through the special facilities placed at my disposal by the Government of India, I was enabled to pursue my inquiries under the most favourable auspices, and to enjoy exceptional advantages of meeting with men of experience and of discussing agricultural matters with them. I cannot pass from this without expressing my sincere acknowledgment for the kindness everywhere shown me by those, whether officials or private individuals, to whom I was commended, and to those who provided me with such splendid opportunities of acquainting myself with the subject which I went out to study. With this introduction of the circumstances which led to my going to India, I pass on to my subject proper—the agricultural needs of India, and how they may be met.

Much has been written, and various opinions have been formed, as to the real condition of

Indian agriculture, and, at the outset, I may be expected to state in general terms whether I consider the agriculture good or bad, and whether it is capable of little or of much improvement. Briefly, then, let me say that so many diversities present themselves in the conditions under which Indian agriculture is pursued, that a general opinion can only be given with so much reservation, that it ceases to be general. In many parts, for instance, I have seen magnificent agriculture, which leaves little or no room for improvement; in others, I have seen inferior cultivation, which, it strikes one, might be bettered. But, when the task of improvement is attempted, I am free to confess that it is seen to be surrounded with difficulties such as are not to be met with in English agriculture, and which require careful and special study. At its best, the agriculture is a "picture" such as might be a model to many a British farmer; at its worst, the inferiority is the outcome mainly of the want of natural facilities, a want which presents difficulties probably unequalled in any other country. I do not deny that instances may be met with where inferior cultivation exists alongside superior, but I came to the conclusion that the determining causes are bound up with considerations of a complexity peculiar to India, and which cannot be treated in the same way as one might deal with questions that present themselves in English agriculture. The work of discovering the agricultual needs may not be so hard a one, but that of supplying them will invariably be very difficult. When the cultivated area of a country is split up into small holdings of five acres or less, when capital is correspondingly small, and the numbers living on the holdings are by contrast great, when the land is subdivided among the members of a family, and they refuse to migrate elsewhere, it becomes hard to say how to proceed in the way of improvement. I cannot do better than quote here the words of one to whom I am indebted for much of the insight I have have had into this subject. I refer to Mr. R. H. Elliot, of Kelso, with whom I travelled to India, and with whom I subsequently stayed in Mysore. In a paper read before this Society, in 1875, he said:—

"If, indeed, I could put nine-tenths of the inhabitants to the sword, take their capital, and hand it over to the survivors, then divide the best of the country into 200 acre farms, or farms of sufficient size to enable them to spare a considerable portion of the land for growing cattle fodder; and if, in addition, I could destroy the whole social system of the Hindoos, prevent the subdivision of the land, teach the people to emigrate . . . . remove their objections to killing off the old and worthless cattle . . . . and finally overcome their objections to the use of night-soil. If I could effect all that, I could easily put Indian agriculture on a satisfactory footing. But, in the absence of such a possibility, I will defy anyone to do more than produce, by slow and painful steps, some amelioration of the existing state of things."

These are, in the main, the views I too have formed; and I am convinced that the work of improvement will be a slow and a difficult one. A circumstance, which tells much in favour of this conclusion is, that wherever I have found an English landholder with native tenants, he has invariably left them to pursue their agriculture in their own way, and has not set about importing English methods or English implements upon his estate, but has been content to introduce this or that improvement just as he has seen the opportunity for its successful *adoption*. Sir James Caird expressed himself as assured of the "practical ability and knowledge of the cultivators of India," and the Famine Commissioners clearly stated their conviction that the work of improvement must be on *native* lines, and be the outcome of careful inquiry into existing methods and practices. In agreement with these authorities, I think that wherever improvement can be made, it will come about by a transfer of the practice of a better part to an inferior one, and by the increase of facilities, such as the supply of water, manure, wood, and grazing, where they are deficient, rather than by any considerable introduction of European methods or implements. That there are differences in the agricultural conditions and practices in different parts of India gives the warrant for believing that an improvement may be effected in the inferior districts; and that much has been already done by Government in supplying facilities to some parts which did not previously possess them, constitutes the ground for urging further advance in this direction. But the line that improvement will take is, I think, that of improvement from *within* rather than from *without*.

I proceed now to consider different ways in which the agricultural needs present themselves, and to attempt to give suggestions for their remedy.

The People as Cultivating Classes.—On the very threshold we are met with a difficulty which acquires a peculiar significance in India, and which is comprehended in the mention

of the word "caste." The fact that, either by religious prejudice or by hereditary practice, some divisions of the people are prevented from being as good cultivators as others, must necessarily constitute a great obstacle to improvement. The Brahmin or Rajput, who thinks it undignified to engage in manual labour, will, as a cultivator, be the inferior of many of the lower but more skilful and laborious castes. The "market-gardener" will cause one to look on with astonishment at his careful toil, and the Kachhi, who does not scruple to make use of night-soil for his land, will show results of his cultivation far ahead of that of those who think the practice a derogatory one. Not only are these "castes" of different agricultural repute, but likewise races, each keeping to his own particular vocation, be he goatherd or grazier, cattle-breeder or milkman, but never departing therefrom. Whether it be caste or prejudice, religious or otherwise, the breaking down of differences in these respects constitutes the first of India's agricultural needs. And yet, progress in this direction will probably be slower than in any other matter, although there are, even at the present time, indications of a change going on. The cultivation of indigo used to be considered an unclean thing, but is now pursued by castes who before would have nothing to do with it; the potato used to be looked on as "flesh," and hence as a thing to be abhorred by Hindoos, but now it is extensively raised; at Nagpur may be seen even Brahmins cultivating sugar-cane by the use of the town-refuse, and Brahmin lads ploughing and doing other field operations with their own hands. The breaking down of caste and of prejudice will undoubtedly be a slow work, but it will most certainly proceed, and more especially when the pressure of circumstances obliges the adoption of the more remunerative practices of cultivation. It will be effected partly by example, that is, the result of a better practice, and also very materially by the spread of education. The exigencies of circumstances which demand the giving of more attention to the cultivation of the land, and the interest in agriculture aroused in consequence of the spread of education, will be the main factors in weakening those prejudices and lessening those hereditary differences which have stood in the way of the extension of the better agricultural practices. The educational work carried on by Government has thus an important bearing upon the improvement of agriculture.

Climate.—The past agricultural year in England was particularly marked by the absence of sunshine during the ripening of the corn crops and at harvest time. This cannot be said to constitute an agricultural need of India; indeed, the reverse is rather the case; and, under the head of climate, what is generally required is a more certain and more distributed rainfall, with provision of shade and shelter. The alteration or modification of the severities of climate is a matter almost entirely beyond human power. People, cattle, and crops, as well as agricultural practices, are influenced by climate; and it is a factor which has to be reckoned with, but cannot be removed. The most that can be done is to mitigate the evils resulting from its severity; and, in two directions, this may, to a certain extent, be accomplished. If canals and other means of irrigation were to be conveyed to those drier tracts of the country which suffer from a scarcity of water; and if the bare surface of the land could be once again covered with trees and forest, undoubtedly some improvement would be effected in the climatic conditions of India. Everyone is ready to concede the first point; but the influence of trees is not so easily apparent. It cannot be positively asserted that, if there were more trees and forest, an increase of rainfall would be the result. But there is no doubt that a lowering of temperature would be produced, and moisture would be deposited where it would have passed on had the surface been bare and heated. A steady rainfall, distributed over a longer period, would take the place of heavy storms and deluges. The increase in the number of rainy days would be of great value to agriculture, for it would permit of the moisture gradually sinking into the soil, and not, as is too often the case, rushing over the dry surface of the land in a torrent, and being, for the greater part, lost. The growing of trees is accompanied by benefits to the soil itself, for it is held up and bound together by the vegetation that soon covers the surface, and the sun's rays no longer striking directly on the soil and so being reflected off from it, a cooler surface is produced, and, in the end, a moister climate may prevail. During my tour I visited several parts where plantations of trees had been formed and were being carefully reserved, and I found that the influence for good, in a climatic direction alone, was clearly acknowledged. The difficulty in India is to secure tracts sufficiently large to exercise any sensible influence on the climate, but, nevertheless, every attempt to mitigate climatic severity, whether by forming

plantations or by growing trees along roadsides, canal banks, &c., will be work in a right direction. Government offers a certain amount of encouragement to private individuals to grow trees, but, after all, anything on a comprehensive scale, be it the carrying out of irrigation schemes or the formation of plantations and "reserves" of wood, must be the direct work of the State.

Soil.—The agricultural needs connected primarily with the soil are two-fold, viz., that of making the cultivated land more productive, and that of bringing other land under cultivation. A rapidly-increasing population, making, as it does, greater and greater demands upon the soil, calls for an increased production from the soil. With this is bound up the famine problem; and it was the estimate of the late Sir James Caird, that if the produce of cultivated land could be increased by one or two bushels per acre, the difficulty could be solved. The inherent nature of soil is fixed by geological conditions, and can only be to a limited extent altered; but its productive power may be increased by such means as the supply to it of sufficient water and manure. Taking the case of wheat, the general yield of India does not exceed 10 bushels per acre, as against the 30 bushels of England; but whereas land that receives but scanty rainfall and no manure will give seven bushels per acre only, the produce of irrigated and manured land will range from 13½ to 18 bushels. It has often been asked whether the soil of India is undergoing exhaustion or not, and to this question I gave particular attention. That there is no clear evidence of exhaustion having actually taken place, I am ready to admit, although no one will be prepared to say that the produce is an increasing one. It is argued that, after a time, a certain level is reached, and that this is maintained without further deterioration. Now, in the case of India, what we see is, exportation of crops, such as oil-seeds and wheat, and also of manures; while, even what is consumed by the people and by cattle is not returned to the land the constituents of which have been drawn upon. Manure is not properly preserved, or it is burnt as fuel; the urine of cattle is wasted, bones and oil-seed refuse are exported, and night-soil is almost universally neglected. In the end, therefore, the soil is having greater demands made upon it; and what is taken off is not being replaced. Whether deterioration will be marked or not, the soil, at all events, will not be enabled to provide the requirements of an increasing population, unless there be a change in the present agricultural system. In brief, it will be necessary to supply to it water and manure where either or both are deficient.

Cultivation has already extended so far, that there is little land left which can be taken up; but there are some kinds of land existing amid the cultivated area which have been considered unculturable. These are mainly the vast salty plains known as *usar* land, the soil of which is impregnated with soda-salts, forming an efflorescence on the surface termed *reh*. Various theories have been put forward to account for the existence of these soda-salts, but their appearance on the surface of soil has been concurrent with the clearing away of forests and the introduction of canals. That canals have directly brought the *reh* I do not think to be the case, but that the water has dissolved the salts and thus supplied one of the elements necessary for bringing them up from below is doubtless true; while the denudation of the land has had the effect of increasing the capillarity of the soil, and so assisting the rise of the salts.

Various methods of reclamation have been tried, and it may be said that it has been shown possible to make *usar* land grow grass, trees, and even crops, by such means as simple enclosure, with exclusion of grazing, heavy manuring, flooding with canal silt, and embanking rain-water upon it. The result, as a financial success, under present circumstances, has not as yet been fully shown, but it is sufficiently complete as to make it certain that if the demand on the land became greater, it would pay quite well to reclaim even *usar* land.

Another class of waste land that may contribute to future cultivation is ravine land, and this, by enclosure and exclusion of grazing for a time, as also by embanking it when necessary, may be covered with trees and shrubs, and may supply stores of fodder, or even crops where sufficiently level.

A third need in regard to the soil is that of obtaining more knowledge about it, and knowledge that can be obtained only by the application of chemical science to its study. In respect of the constituents of soil, their efficiency or deficiency, their supply in the most suitable form, the connection of plant life with the soil on which it grows, and the atmosphere from which it likewise derives nourishment, there are many questions which remain unsolved in Indian agriculture. Such an inquiry as the reclamation of *usar*, for instance, manifestly calls for the employment of chemical science.

Water.—That water is, over a great part of India, one of the chief agricultural needs, has been generally recognised, and Government has not been slow to take up the important question of its artificial supply to tracts that suffer from deficiency of rainfall. Famine is the direct result of failure of rainfall, and hence attention has been most naturally turned to supplementing it, more especially in those tracts which are known as "precarious" ones. It is not the districts where rainfall is lowest that are most subject to famine, for the cultivator will not put in his crops at all here unless he has a sufficiency of water; but it is those where rainful is variable—sometimes failing altogether — that the cultivator is induced to risk the growing of a crop, which, should rain not come, may fail entirely. The ways in which water may be supplied, vary with the geographical and geological conditions, and it is necessary to exercise great care before deciding whether irrigation is to be carried on by canals, by wells, or by other means. In extending canal irrigation, the main object should be to take it where no other available supply of water exists, and to provide for as large an area as possible. Various objections, some of them well-grounded, have been urged against canals, that they have been taken where not needed, that they have raised the water-level of the country, spoiled the wells, obstructed the natural drainage, and brought ill-health to the people, as well as causing the spread of the salty efflorescence *reh*. Undoubtedly, canals have in some cases in the past, as in Orissa and Behar, been taken where they were not required; and, in others, their alignment has been faulty, while, as already noted, canal water may indirectly be connected with the appearance of *reh*. But it must be allowed that the Irrigation Department is now careful to avoid the errors of the past as far as possible. The coming of a canal to a district has certainly, in some instances, been productive of fever and ill-health; but it has also produced an immunity from the ravages of famine, and between the two evils the choice must lie. It has been proposed to try subsoil-drainage as a remedy for water-logged lands, and though the difficulties and cost would be very great, I yet think that in parts which are most affected it might be experimentally tried. In connection both with canals and river-channels, much good might be done by the storing of water in reservoirs, to be used for irrigation purposes. Such reservoirs might be made at the end of canals, or by intercepting river-streams, such as those in Southern India, before they find their way into the sea. The great difficulty in supplying water by flow, whether from canal or storage reservoir of any kind, is to check the wasteful use that is made of it. When water has to be raised by lift, as from a well, it is found that far less is used, and that the cultivation is more careful too. All attempts at charging a water-rate on the quantity used have, however, failed. The over-use of water must tend to remove much of those constituents of the soil which would go to feed the crop, and it induces the over-cropping of the land. The "coldness" attributed to canal water is mainly the result of over-watering, which brings about a cold stagnant state of the soil, as exemplified in the case of badly drained clay land, whereas the well-water applied in lesser amount, and raised by lift, is known as "warm." There are other interesting features distinguishing canal and well-waters, the latter often containing considerable quantities of nitrates and other salts, and when this is the case they are held in special favour for tobacco growing. The water of some other wells is, on the other hand, considered unsuitable, and there is clearly work for the chemist in a study of this subject and of its bearing on agriculture. In some cases, not the supply of water, but the checking of its rapid flow over the land, may be the agricultural need, and the advantage of embanking land has been experienced in many parts, mainly in the Central Provinces.

Though much work has been done by Government in projecting canal irrigation schemes, and in encouraging the making of wells, tanks, and other reservoirs by the inducement of a Government advance at a low rate of interest, very much still remains to be done, and the recent distress in several parts, notably in Madras, consequent on the failure of the monsoon, emphasises the point. At Bellary there are no canals, only a few tanks, and the wells are 45 feet down, the solid rock having to be cut into to make them. Kurnool, Madura, Coimbatore, Ajmere, and Jhansi are other places where irrigation is urgently needed. The difficulty with many of the proposed schemes is, that, unlike most of the existing canals, they cannot be considered as remunerative, but purely as measures of a protective nature. It has been ascertained, too, by inquiry, that it would not in general pay Government to undertake the construction of wells on a large scale, but that this can be better done by the system of advances to

cultivators known as *taccavi*. In the working of this system, however, distinct improvements can be effected, and my experience convinced me that the adoption of this system by the cultivators is almost entirely dependent upon the personal activity and interest of the collector or other Government official of the district. Where this interest is shown, the *taccavi* system is popular, but where difficulties are thrown in the cultivator's way, he will prefer to resort to the money-lender for any of his requirements, although in the end it may cost him far more. I read only recently in the *Times* that no less than 10 lakhs of rupees (say £65,000) had been advanced in the Kurnool, Bellary, Anantapur, and Cuddapah districts for the purpose of well-digging alone. This but shows what room previously existed for the extension of well irrigation. In the prompt repair of tanks and other reservoirs an improvement can also be effected. But beyond these points there is evidence of the necessity of a closer study than has yet been made of the requirements of each district in respect of the provision of water supply, and of the way in which that may most suitably be carried out.

Manure.—Inseparable from, and nearly as important an agricultural need as the last one, is the supply of manure to the land. Indeed, from its having had far less attention given to it than the provision of water, it should now have particular prominence, for practically nothing has been done to increase its supply. Again, water and manure are practically interdependent. Without water, either in the rainfall or supplied by irrigation, manure is useless; without manure, water will wash out and gradually impoverish the soil, so that its fertility can only be restored by manure. It is but necessary to mention the sugar-cane cultivation around Poona, or the market-gardening of Meerut, Amritsar, Hoshiarpur, and other places, to exemplify this. In India, as in England, the crop-yields go up and down, according to the amount of manure available for application; and, if India is to produce the extra bushel or two per acre which Sir James Caird estimated it must do in order to supply the wants of an increasing population, it is very certain that it cannot be done without increasing the manure supply to the land. It is manure alone which can replace the soil constituents carried off in the crops, and to a considerable extent exported to other countries. When we come to consider the available sources of manure in India, we find them extremely meagre, and still more reduced by the poverty of the cultivator, which prevents his using to the best advantage even what he has. The universal manure the cultivator has is the solid droppings of his cattle, and the value of this he fully appreciates, but complains that he has not enough of it. The scarcity of fuel obliges him to burn the greater part of what should rightly be put on his field, to restore the fertility removed from it in the crops grown. When pondering over the question of agricultural improvement, I have often witnessed with regret the long lines of women carrying in baskets on their heads into the towns the dried cow-dung cakes, or *bratties*, that are to be used for burning as fuel. I have carefully examined the statements that have gained currency, to the effect that the dung of Indian cattle is poor in quality, and that even if burnt it loses little or nothing of value, as the ashes find their way to the field again, and the nitrogen lost in the burning comes down again in the rain, which, on that account, is richer in compounds of nitrogen than is the case in temperate climes. But the latter assertion is unsupported, for the analyses upon which it was based have since been shown to have been incorrect, and that Indian cattle manure is not poor I can prove from my own analyses. My results show that for every ton of manure burnt no less than 29¼ lbs. of nitrogen out of a total of 30 lbs., or 97·5 per cent., are entirely lost. Nor is this all the loss sustained, for the organic or vegetable matter is also destroyed, and it is in this and in nitrogen that I find Indian soils are mostly deficient, while the mechanical advantages of farmyard manure and its moisture-holding properties are lost also. The saving of the cattle manure, as far as possible, for use on the land, is, to my mind, of paramount importance. It has been said that the cultivator will always burn *bratties* for fuel, but, thought his is a general rule, I have found that among cultivators pure and simple it is not an universal rule, and that though it has become a practice, it has become so, mainly because of the absence of wood or other sources of fuel. Away from the towns, manure is hardly a purchasable material, and I have been in several parts where all of it is saved for the fields; here the cultivation has been of the best. Great improvement is possible, however, in the method of preserving manure, and chiefly in the saving of the urine, which is universally allowed to go to waste. Were but leaves, stalks, straw, or other forms of litter used, the available manure

supply might be largely increased. The next way in which an improvement might be effected is by the utilisation of night-soil, house-sweepings, &c. Prejudice is, undoubtedly, a great hindrance, but the instances which Poona, Amritsar, Meerut, Farukhabad, Cawnpore, Nagpur, &c., afford of what can be achieved when it is overcome, leave no room for doubting that great possibilities of agricultural improvement exist in the utilisation of such waste materials. A few weeks ago a paper was read in this room on the subject of sanitation in India, and I cannot help expressing the hope that, in any schemes which are brought forward in future, the importance of the agricultural side of the question will not be lost sight of. Many kinds of oil-seed are pressed for the sake of their oil, but the refuse-cake is frequently exported, and not used in the country to any extent, while folding of cattle on land, and green-manuring are only practised to a limited degree. Bones are exported from India because of the prejudices that exist against their collection and use, and because of the difficulty of preparing them for application to the land, but largely also because of there being merchants able and willing to give more for them for export purposes than the people of the country value them at. For the use of artificial manures I think there is not the least hope, so far as the ordinary cultivator is concerned, and principally on account of his want of capital. The greatest importance attaches accordingly to the utilisation of those materials which every cultivator has at hand, and which will not become the subject of export.

Wood.—The next agricultural need is the supply of wood. Only too late has it come to be realised that in denuding the country of its wood and forest land, in order to make room for cultivation, an injury has been done to agriculture which it is impossible now to remedy entirely, while even in so far as a partial amelioration can be effected, its progress must be slow and difficult. Leaving aside for the present the importance of a supply of timber, I would revert to what I pointed out in the last section, viz., the impoverishment of the soil consequent on the burning of the cattle manure which should find its way back to the land. This wasteful practice is the direct result of the clearing of the former wood and forest land, and it will continue until the cultivators can be provided with wood to serve them as fuel. Thus the creation of supplies of wood is a way in which one of the principal agricultural needs of India may be met. The Forest Department, though originally concerned with the preservation of the more distant timber forests, and having no agricultural object in view, has in later times come to see that as cultivation has spread, the wooded tracts should be made to serve more nearly the interests of agriculture as well, and that the reservation of areas and the creation of fresh ones in the midst of cultivation, is a legitimate and desirable part of its work. I go so far indeed as to regard the supply of wood for replacing dung as fuel as the one practical measure from which the greatest benefits to agriculture will accrue, and I think that sufficient importance has not been given in the past to the close connection of the provision of wood with the maintenance of the fertility of the soil. Mr. R. H. Elliot, of Kelso, was one of the earliest to draw attention to the importance of this connection, and in his paper read in 1875 before this Society, he urged the necessity of having "fuel reserves" for India. A supply of wood to serve as fuel means the liberation of manure for the land, the growing of larger crops, the supply of more fodder, the maintenance of better cattle, and in turn more manure again for the land, while to the State itself an increased revenue would accrue consequent on the higher cultivation. The growing of trees would also provide a large amount of leaves which might be usefully employed as litter, and thus save the urine of the cattle from being wasted. Nor must, finally, the beneficial influences upon climate be omitted, though to these I have already alluded. It is very certain that the existing "reserved forests" would not be sufficient or even be suitably placed to provide for the agricultural requirements of the people in the matter of wood and fuel supply, and there are many districts, notably in the North-West Provinces, where trees, and (much more) forests are nearly unknown. The difficulty is, that where wood is most wanted, there land is most taken up by cultivation, and that where it grows freely, there is no cultivation to require it urgently. Nevertheless, even in the North-West Provinces it has been shown there are considerable areas of ravine land available which might be turned into "fuel reserves," and that even on the vast salty or *usar* plains, the growing of trees and grass may be accomplished. In Madras, the waste land all belongs to Government, and here, upon the banks of rivers and channels, as well as on tank beds, trees might be grown. In Ajmere-Merwara, it

has been shown that mere protection and exclusion of grazing for a time, aided by planting here and there, will soon clothe even seemingly barren hills with trees and shrubs. Plantations of trees have also been created in many parts along canal banks and railway lines. The result of inquiries made has been to show that considerable areas are still available for tree-growing purposes, but where these are not sufficient, the only plan is to acquire land for the purpose. The financial prospects of such a scheme may not appear at first sight favourable, but there is more to be considered than the actual money returns from the sale of fuel as fodder. Practically, as I have said, it is the well-being of the people, and the keeping up of the soil, and hence, of the land revenue to the State, which are concerned, and these cannot be measured by the direct financial return alone.

Grass.—The provision of grazing, and of grass for cutting as food, is another agricultural need, though, to my mind, not of equal importance with the supply of wood. The establishment of "wood reserves," however, would imply the growth of a certain amount of grass, which could be cut and used as fodder, even it it were undesirable to permit grazing to be carried on. The most distant forests include large pasturage areas of much value, to which breeders of cattle and graziers resort, and the retention of these areas for such purposes is most desirable.

Although the cultivator may send out his better cattle, under the charge of herdsmen, to these grazing areas during the hot season, they do not supply all his needs, and something nearer at hand is wanted. It is the provision of grazing in "reserved forests" that the cultivator seeks to have, and it is this which has, in times of drought, already done great service in keeping the cattle of the country alive. It has been rightly pointed out that the growing of fodder crops would not efficiently replace grazing, for, in times of drought the fodder crops would probably fail as well. If grazing areas can be made in "reserved forests," the benefits to agriculture will be great, more especially in exceptional times; nevertheless, I cannot regard it as more than a desirable end for forests to serve in ordinary times, but not as an absolute necessity. Therefore, while utilising "reserves" in this way, wherever it can be done, grazing should be carried on only when the general utility of the "reserve" as a wood or fuel-producing area can permit of it. Thus, while natural reproduction is going on, the admission of grazing is out of the question; similarly, the number of cattle admitted must be restricted, the seasons at which they are let in must be limited also, while goats are so destructive as to have no place in a forest, except it be on an area set apart for them. The necessity of having stringent rules as to forest fires, and of preventing the setting on fire of the dry grass in order to get a fresh growth, is abundantly justified. Wherever in a "reserve" it is possible to admit cattle to certain blocks at a time, a useful end will be served; but unrestricted grazing will ruin any "reserve." At early establishment of a "reserve" it will be necessary to exclude grazing altogether, and, as a rule, I should be in favour of cutting and removing grass in ordinary times, rather than of feeding it down by stock; in exceptional times of drought, however, the "reserves" should be thrown open. The village grazing - ground, or "waste," is a useless institution, so far as grazing is concerned, and it serves no purpose but to provide standing and exercise room for herds of half-starved cattle. These village wastes are lamentable examples of what unrestricted grazing will do, and they may be productive of positive harm as affording a ready means of spreading disease should it break out. The best thing that could be done would be to enclose the wastes and restrict the grazing on them; but it is a difficult matter to interfere with the villagers' inherited privileges.

It has been suggested that the growing of grass by the cultivator upon his holding should form a part of his farming system, but this could hardly be done without irrigation, and as the first object of the *raiyat* is to grow crops that provide him with food, and his cattle with fodder, he is hardly likely, I think, to set land apart for pasture purposes alone. It has been said also, that India will be the great field for the development of ensilage. This I cannot think to be the case, although here and there, as on military *rukhs* and grass farms, it may be usefully employed. When hay cannot be made, grass may be saved as silage, but the conditions of India are far more favourable to the making of hay than of silage.

Fodder-crops.—The growing of special fodder-crops may, in one way, be termed an agricultural need, for though, like grazing, not an absolute necessity for the existence of cattle, it is, nevertheless, necessary for their improvement. The superiority

of the cattle of the Punjab is largely due to the practice of growing fodder-crops, and the same is seen when comparing the cattle of the European planters in Behar with those of the native cultivators. There are also many materials, such as hedge-clippings, prickly-pear, pods of the *babul* (acacia) tree, and shoots and leaves of other trees which might be more used as fodder. In this connection, the advantage of enclosing fields with hedges, and of penning cattle on the land, might be mentioned.

Cattle.—In the rearing of stock there is not much to be learnt from the native cultivator. Here and there, fine cattle are bred, and special strains are kept up ; but, as regards the ordinary cultivator, there is hardly any attention whatever paid to the breeding or selection of cattle. The sacred or Brahmini bull, who roams at will over fields and through villages, is in many parts becoming extinct, and the breeding of stock is left greatly to chance. There is little doubt that by providing good stud-bulls the cattle of the country might be greatly improved. This is work which Government has for some time carried on at farms, such as the Hissar Cattle Farm in the Punjab, the Amrit Mahal Farm in Mysore, and more recently at Bhadgaon in Bombay. The fine cattle of the Punjab owe their present excellence largely to the bulls sent out from Hissar. It would be a great good to the country were this system extended to other parts, and bulls to be distributed to villages, there to be placed under the charge of the village headman, who in turn should be required to report to the local authority. There is plenty of good material to be found in India, if only selection were made, and there is no occasion or advantage to be gained from going beyond India. The location of stud-bulls at Government farms, and on Court of Wards' estates, would benefit the cattle of the district, and, though the result might not be a directly paying one, the step is one which might well be taken in the interests of the agricultural classes.

As a milking animal, the buffalo is more valued than the cow, and is generally well looked after by the native, so that here there is no call for improvement.

Attempts have recently been made to improve Indian dairy methods, but I am not inclined to think that English methods will take the place of native ones in any parts except large towns, and where there are European residents. The native butter, called *ghi*, is hardly likely to be replaced by butter as known to us in England, for the simple reason that the latter will not keep as *ghi* does. But what there is decided need for, is, to remedy the existing conditions of the milk supply, more especially to troops and to Government institutions. At present the surroundings are almost always of an insanitary nature, and neither control nor inspection is exercised over them. Where troops are regularly quartered, dairy farms might, with great advantage, be established.

Yet another need arises in connection with cattle, the gaining of more information with regard to the diseases of cattle, and the means of curing them, as also the prevention of the spread of epidemics. Of late, a decided step has been taken in this direction, by the establishment of a bacteriological laboratory at Poona, and a similar move is in contemplation at Lahore. The enormous losses that take place through cattle disease, and the stoppage of agricultural operations in consequence, demand that serious attention be given to the investigation of these evils and their means of cure.

Implements.—It is only in a very limited sense that I am prepared to consider better implements as an agricultural need of India. Until an iron plough can be produced which does not cost more than the native wooden one, and which can be repaired in the cultivator's village, I do not think it is likely to replace the present plough, nor am I convinced that, on the whole, the change would be an advantage under the present conditions of Indian agriculture. Similarly, there is little scope for the introduction of sowing, reaping, or threshing-machines. In appliances for raising water, the native has shown himself an adept, and there is nothing we can teach him in this. The one instance in which a great success has followed the introduction of an implement new to the Indian cultivator, is that of the iron mill for pressing the sugar-canes. After several years of patient study of native requirements, Messrs. Thomson and Mylne, of Beheea, brought out a portable sugar-mill which exactly suited the cultivator, and was far superior to any of the native implements. The consequence was the ready adoption of the new mill, and the replacement of the old ones. Similar, but more limited benefit may result from the introduction of shallow evaporating pans for sugar-boiling, instead of the deep ones often used. But in every case where an introduction is to meet with success, it will, I am sure, only be as the outcome of

careful study of native conditions and requirements.

Cultivation.—I have, at the outset, expressed my opinion that the improvement of cultivation is, in the main, not an agricultural need in India. In brief, there is little that may not be remedied from India itself. Still, there are one or two "needs" in regard to cultivation that I may just touch upon. Though the cultivator understands the advantages of rotation, and would practise fallowing if he could afford to, he does not appreciate the advantage of selection and change of seed. That this is so, arises largely from the practice of resorting to the grain-merchant, who is also the money-lender, in order to obtain an advance of seed for the crop that is to be grown. He is therefore dependent upon what the money-lender supplies. Thus it becomes impossible to preserve pure varieties of cotton or other crops, for the seed is brought in in small lots, mixed together, and then sold again. It becomes, therefore, one of the most useful purposes which Government farms may serve, to grow pure seed and to have it available for distribution to the cultivators. In this way the Cawnpore farm of the North-West Government has already done very useful work, and the extension of seed-farms to serve as centres for the distribution of good seed is to be much commended. A certain amount of advantage may be derived from the introduction of new crops and new varieties of crops, and the history of millet, maize, tobacco, tea, coffee, potato, &c., tells of the success attending the importation of new crops. But the main benefits will be experienced in the transference of methods of cultivation from one part of India to another. Even in rice-growing, but still more in sugar cultivation, there are methods practised in one part which are superior to those adopted in another, and if, as the result of careful inquiry into existing practice, this transference can be accomplished, the result will be a general bettering of the cultivation. It is very certain that both the cultivation and the out-turn of sugar in India could be very considerably increased, and that India ought in this matter to be rather an exporting than an importing country. There is comparatively little known about the circumstances which affect the yield of sugar, and the manufacture would be much improved were more cleanliness employed. The curing of tobacco is carried on in a very crude way, although the cultivation is of the most careful kind.

I have now given in brief review the principal agricultural needs of India as they impressed themselves upon me during my inquiry. In the course of my remarks, I have had occasion to refer, in passing, to other needs than those specifically named, such as the necessity of inquiry, both of a practical and of a scientific kind, as also to the need of spreading education. It is impossible in a paper like the present to deal with all these large subjects, and, as they are to form part of a forthcoming report, I have considered it better to confine myself on this occasion to matters of a more strictly practical nature. There are also, as I said in my opening remarks, great questions affecting the prosperity of agriculture, which are concerned mainly with the relations of the State to the people, and of landlords to tenants, as well as others inseparable from a consideration of the social habits of the people, their ways of living, &c. These questions all require for their proper treatment a far wider experience of the people and of the country than I have been able, with my limited opportunities, to gain; and, for this reason, I have not attempted to deal with them.

DISCUSSION.

General J. MICHAEL, C.S.I., said Dr. Voelcker had touched upon a very important point, in saying that India's most urgent need, next to water, was manure. They all knew how the ryot, for want of fuel, was obliged to burn the manure, which he would only too gladly put on the land; and there was here room for further aid by the Forest Department. During the last half century that department had succeeded and developed to such a marvellous extent, and so far beyond all expectation that, after paying all its own expenses, it now yielded a revenue of over half a million sterling. Having that large revenue, it could afford to do more than it had towards providing free fuel reserves for the villager, so as to enable him to utilise his cattle manure instead of burning it. The Chairman had been good enough to allude to him as the pioneer of practical forestry in India, and he well remembered when the forest operations commenced in Southern India, the Madras Government wisely laid down the dictum that the preservation of natural resources in the forests, which included fuel, should be the first consideration, and the acquisition of revenue the second. That principle had been to a great extent maintained, but it might be extended, and a larger area of fuel reserves provided. By so doing, it would be lending money to the soil, which would be repaid by increasing prosperity in the future.

Sir C. E. BERNARD, K.C.S.I., said it was very satisfactory to find that Dr. Voelcker, after careful in-

quiry, had come to the conclusion that Indian agriculture could only be improved on Indian lines, and that he recognised the fact that India consisted of many countries, climates, and kinds of agriculture, so that any one system of improvement could not apply to the whole country. He had also found that in some parts the agriculture was already of a very high character, and that a reformer should make it his object to apply locally—as they were suitable—the best plans already used in other parts. What India wanted most was manure and water—manure first—and, as General Michael said, the Forest Department was doing what it could to make fuel available. In some parts of the country cattle droppings could be little spared for the manure, but in Burma, where there was plenty of fuel, it all went on to the land. In some parts of India—in the great delta of the Ganges, for instance, and in the north of India—there was not much chance of growing forests, but there was another source of fuel, namely, the coal-fields, which might hereafter be made generally available, so that the cultivator might have the manure available to put on the land. In some parts, water was the great need, but, in other parts, the difficulty was to keep the water off the land. In the Godavery delta, water was a great blessing; but in some parts. such for instance as the black soil country of Kurnool and Cuddapah, there was a great difficulty in getting the people to take canal water. It was very true that more agricultural teaching education was required, and it should be not primarily to the cultivator, but to the village schoolmaster. Dr. Voelcker had quoted, with approval, Sir James Caird's dictum, that a great want in India was to get an additional bushel per acre off the land. At the Cawnpore farm, last year, on 30 plots, the average yield was from 33 to 43 bushels per acre, and the largest yield gave a money profit of 87 rupees per acre. Of course, that was good land, well irrigated and manured, near Cawnpore. The manure was not foreign manure, but that available on the spot—indigo refuse and lime. The great problem for the Government of India was the enormous population, which was increasing at the rate of 70,000,000 in a generation, and how that population was to be fed. Certainly that increase of population, which was quite unknown in former times, was a great credit to the Queen's Government, and was in some degree an answer to the pessimists, who say that India is being ground down and her people are perishing under foreign and alien rule. But although this was, in one sense, a cause for satisfaction, it was a source of great difficulty. He hoped that Dr. Voelcker's forthcoming report would form a valuable step in the agricultural progress which must take place in India if that country had to support such an enormous population.

Lord Reay said he agreed with most of the conclusions put forward in the paper. With regard to education, he might say that while he was in Bombay they obtained from the University a diploma in agriculture, intended mainly for those who had been through the agricultural course of the College of Science in Poona, which the indefatigable efforts of his friend, Dr. Cooke, had raised to a high state of efficiency, and it was a great disappointment to him that he could only obtain a diploma, not a degree in agriculture such, as was given at Edinburgh, from the Bombay University. He agreed with what had been said about the importance of schoolmasters being taught agriculture, but there was another class to whom it would be of the highest importance, and that was the native official who lived in the rural districts, and who was constantly in touch with the people, to whom he would thus be able to show how to make the best use of what he had been taught. The Government of Bombay had carefully considered the possibility of including in the examination of such officials the precepts and practice of agriculture. The want of a knowledge of agricultural chemistry was also felt by the Bombay Government, which had tried to obtain from the Government of India the appointment of an agricultural chemist for the whole of India, to be paid by contributions from the various provinces, but he was afraid no effect had as yet been given to the proposal. He was happy to say that the Bombay Forest Department thoroughly realised the importance of supplying timber for fuel; with due attention to working plans and regular cuttings, as well as settlements and careful supervision of grazing areas, the people wonld gradually realise the benefits of conservancy. He did not quite agree with a previous speaker that the department did not care about increasing the revenue. In Bombay, the conservators certainly wanted to have a good surplus, but this was compatible with the supply of fuel. Another point of great importance was the Veterinary Department. In Bombay, the veterinary school had been placed on a better foundation, and the results were most satisfactory. Horse breeding also was a matter of great importance, from an agricultural as well as from a military point of view; and a great deal could be done in that regard in the native States. In Kattyawar the native chiefs had taken it up, and perhaps no class in India could do more to prevail on their countrymen to adopt improved methods of breeding and of tillage of the soil than the native chiefs. The Gaekwar of Baroda was fully aware of this, and in his College at Baroda had appointed a Professor of Agriculture. Another means of promoting agricultural improvements was not to raise the assessment on the land too suddenly or too rapidly, and this also was borne in mind in the Bombay Presidency. The late Mr. Theodore Stewart, one of the best Survey and Settlement Commissioners they ever had, always tried to increase the assessments cautiously, so that the cultivators should have a sufficient margin to improve their holdings, and he considered that the indirect benefits which would accrue from such a wise procedure

would be infinitely greater than any additional revenue which could be obtained by a process of rack-renting. On the relations of the money-lender to the agriculturist he would not dwell, as a Commission was inquiring how they affected a ryot. Any prejudice which might have existed in the Brahmin caste against agriculture had given way in the Bombay Presidency, for Brahmins were now investing in land. This would naturally tend to alter the tenure of land, and might bring about what Sir James Caird desired to see—a system of larger holdings instead of the small "number" hitherto the distinguishing feature of the Bombay tenure. With regard to irrigation there was a great difficulty. His experience in Bombay, excluding Sind, was that agriculturists only took the water at the last moment, under pressure of extreme drought, and, therefore, in years when the rainfall was scanty, but not wholly insufficient, the canals would not pay. The receipts, therefore, were irregular, but in Deccan, where the rainfall was uncertain, the irrigation water was certainly needed to supply a deficiency, and he thought it well repaid the cost of the good work the Irrigation Department was doing, as it gave the occupant a sense of security which otherwise he could not feel. He was glad to say that the experience gained in India was now made available in Egypt, where he had recently seen with pleasure the excellent results obtained by Colonel Sir Scott Moncrieff and other Indian Engineers—results thoroughly appreciated by the fellaheen who depended on water for their crops.

Sir Steuart Colvin Bayley, K.C.S.I., said much which he might have said had already been put to the meeting by previous speakers. Dr. Voelcker had wisely abstained from discussing administrative or revenue questions, and had described the practical needs and suggested practical remedies, namely, irrigation and afforestation, the improvement and increasing of manure, and improved cattle-breeding and doctoring. If none of these remedies were new to those who had taken an interest in the matter, it did not at all detract from the soundness of the advice. There was one remark, however, to which he might take some exception. He spoke of the canals not being always placed where they were wanted, and about the injury they undoubtedly caused, and, amongst others, he mentioned the canals in Behar. They had not been a financial success, but he could not admit they were not wanted. They were wanted there, and had done incalculable benefit, for they had saved lives and money in the way of revenue, which far more than repaid, in an indirect way, their original cost. They had, however, materially changed the cultivation in the district of Charterabad. The land formerly only grew *rabi* crops, but the result of giving water freely had been that rice had supplanted *rabi* to a large extent, to the pecuniary profit of the cultivator, but also to his physical detriment, because the district, which was a remarkably healthy one, was now feverish and unhealthy. The remarks with regard to the difference between lift and flow irrigation had a very important bearing. It was not an advantage to the cultivator to get water too cheap or too easily, or too much of it. With regard to the question of manure they were greatly indebted to the reader of the paper for effectually destroying the pestilent heresy that the ash of burnt cow-dung was as beneficial to the land as the unburnt manure. Some newspapers in India had taken up the cry, and it would have kept the cultivator in a fool's paradise. Irrigation and manure ought to go together. Irrigation without manure did harm after a certain term of years. Artificial manures were impossible to the native ryot at present; and, therefore, if the supply was to be increased, it must be by supplementing their fuel reserves. On that general principle all would be agreed, but when it came to working the thing out in practice there would probably be differences of opinion, and he did not see how it was to be done. The Forest Department was a highly organised department with expensive experts. They were quite in their place in dealing with large areas of forest reserves, mostly in the sparsely-populated districts, where they came into contact with outlying tribes, whose agricultural methods were of a very low type, and whose real interests were by no means always the same as their immediate demands. But if we want fuel reserves to be of any use at all, they must be brought almost to the villagers' door, and where the population was thickest all the land was already used for food crops, and it was not very easy to see how land was to be taken up and planted, and machinery provided for distributing fuel and arranging for its reproduction. In Bengal the officials were not in touch directly with the agriculture of the country, but in other provinces, where village communities still remained, and Government officials were in direct touch with the people, there might be some means of coping with the difficulty. It was quite true, as Dr. Voelcker said, that the Government could not go in for a large system of well-digging, but should pursue the system of *toccavi* advances for well-making; but the success or otherwise of this method depended very much on the interest and personal character of the collector. He knew an officer in the Bengal Opium Department who had been at Sawan for twenty years, and took great interest in the question of well irrigation. He persuaded the opium agents to make advances for wells to the cultivators, and the whole of his division was thoroughly protected against drought as far as any country could be by that means. Too much attention could not be paid to improved cattle breeding. In some parts of India—in Bengal and Assam, for instance—nothing could be worse. He believed the agricultural community kept far more cattle than was necessary, or than they could afford to feed. If they had half the number, properly fed and housed, and systematically bred and doctored, they would be far better off.

He hoped that Dr. Voelcker's mission would be fruitful in benefiting India, and that, before long, India would have the advantage of the advice of a permanent agricultural chemist.

Professor WALLACE said this paper was thoroughly orthodox, in fact, his principal complaint was that it was too orthodox. It was unnecessary for him to follow other speakers in saying how much he agreed with Dr. Voelcker, he would rather criticise, and say the worst he could about it. It was not so much what Dr. Voelcker had said himself, as the quotation he had made from Mr. Elliott, which he objected to. Mr. Elliott said that if he could put nine-tenths of the inhabitants to the sword, and divide the best of the country into 200 acre farms, and so on, he could easily put Indian agriculture on a satisfactory footing. But how were all these farms to be cultivated if the inhabitants, or a greater part of them, were got rid of? Dr. Voelcker said he did not believe in the introduction of English systems, but in developing Indian agriculture from within. But what was he going to do if he did away with the labourers who now worked in the fields? This would require the introduction of expensive machinery. So the quotation seemed hardly consistent with his own notions. Mr. Elliott also referred to destroying the whole social system of the Hindoos, teaching the people to emigrate, and so on, and said that in the absence of such a possibility it was impossible to do more than produce by slow and painful steps some amelioration of the existing state of things. Dr. Voelcker said those were in the main the views he had formed, but then he went on to show that he did not quite agree with all this, because in some parts the cultivation was excellent. How did that come about? It was not so at the beginning. The Indian cultivator had shown himself capable of carrying out improvements in his methods of cultivation; and, again, no less than ten lacs of rupees had been spent in one district to develop irrigation. The Behea sugar mill had been introduced; and the Brahmins had taken to agricultural operations. He had travelled with a Brahmin from Bombay up to the northern part of India, and he must say that that Brahmin's conduct and conversation opened his eyes considerably. He said he should be only too pleased if he saw openings to train up one or more of his numerous family to agriculture. It was to be regretted that Dr. Voelcker had not said anything of the most recent advance in agriculture in the way of supplying manure. He quite agreed that manure, together with irrigation water, was the one thing needed in India; but he totally disagreed with Dr. Voelcker that the way to get it best and cheapest was to deprive the natives of the only fuel that they had. It could be got in a cheap and ready way without depriving the people of anything they at present possessed. Within the last few days information had come from America that the great boom in the Western States was a development of the growth of clover on exhausted wheat lands. This formed the cheapest, best, and most suitable source of nitrogen, which was the most valuable of all manures for India or any other place in the universe, and it was only on account of the loss of nitrogen that the burning of manure could be condemned. The other substances were not destroyed, but, on the contrary, they were improved and made more available. Humus, unless when fresh (and the same remark applied to stale dung in the soil), was in a very insoluble condition, not at all suitable to assist the growth of plants, and when burnt to ashes it was much improved. If then nitrogen were supplied by the growth of leguminous plants, the main object would be gained. Western Americans have recently discovered that they can grow clover well, and that it can resist drought when planted two inches deeper than formerly. This is expected to add two or three bushels per acre to the produce of wheat. Some simple thing like that might do a great deal for the development and increase of the average production in India. In fact they were simply on the threshold of agricultural experiments. He rather demurred also to the statement with regard to silage. He asserted that good hay could not be made in India at the season when grass was most plentiful. Silage had its place, and it was an extremely valuable and important addition to food, especially in countries liable to severe droughts. With regard to *usar*, drainage and washing was the only cure. He had seen it in nearly every quarter of the globe; and if you only supplied a sufficient amount of water, and provided means for its escape, *usar* would disappear naturally. He could not sit down without saying one word in support of the idea that Indian implements were, in the main, good for the sort of cultivation they had to perform. This was not a new idea to him, for he was immensely interested, some years ago, in an article by Sir George Birdwood on the Mahratta plough; and it seemed to him that, by showing our appreciation of what was good in native practices, we should make the natives think more of themselves, and they would also be more inclined to take advice from us when it was offered.

Mr. THISELTON-DYER, C.M.G., F.R.S., said the statistical tables published by the Board of Agriculture showed that the produce of wheat in India was about nine bushels to the acre; in Scotland, it was about 36 bushels; in England, about 30; and in the Western States of America about ten. Wheat production in India, therefore, and the United States, was about the same, and that meant that the fertility of India and of the great corn-producing districts in the States, had come down to what might be called the mean natural fertility, or that condition which the soil ultimately arrived at when you went on cultivating and did not add any manure. There was no reason to suppose that the soil of India would become any less fertile

than that. And it was far from having lost the recuperative power of grain-cultivated soil. They had been told that it was possible in India to get 48 bushels an acre, which was far above what was done by the careful agriculture of Scotland. There was, therefore, no doubt that results could be obtained far beyond the modest demand which Sir James Caird made. But there was a further fact that in the past generation population had increased by 70,000,000, and so one came back to the question, what was to be done to produce from the soil sufficient food to keep up such a population. Of course, it would not go on at that rate, because the ordinary Malthusian principles would come into work sooner or later, and the contrast between the fertility of the soil and of the people would diminish. During the last twenty years, he had been consulted more than once by the Secretary of State on this question, for although he had never been in India, he had given a great deal of attention to official documents bearing on it, and it was perfectly clear that the real question was, how to get more nitrogen into the soil. That point overshadowed everything else. He had anticipated the difficulty Sir Steuart Bayley raised, in the substitution of wood for manure as fuel, but he could not see how stopping burning manure would give a sufficient supply of nitrogen to produce the results desired. Professor Wallace had indicated one way, and about that there could be no doubt theoretically. After the studies made in Germany, France, and England, there could be no longer any doubt that the growing of leguminous crops did enrich the soil with nitrogen in a way which, as far as was at present known, without manure, could be done in no other way; but in India the method of green soiling was not altogether unknown. If it were, the sooner some popular account of the method was distributed the better. An old pupil of his own, who had charge for a time of an experimental farm at Bangalore, found that by making some slight addition to the Indian plough he was able to stir the soil—not to plough deeply, but to stir it lower than the ordinary plough did, and, by slightly opening the subsoil in this way, the roots were able to get down lower, and the crops, even in a season of drought, flourished in a way they did not when the soil was cultivated in the ordinary manner. He was inclined to think that the Indian plough was a thing which deserved a good deal of study; but it could not be studied very well by people in Europe, because our conditions were so different. The study should be made on the spot, and efforts should be made to improve the agricultural methods there by the introduction, if possible, of some kind of rotation with leguminous crops. He was under the impression that, in a great deal of the cultivated land of India, there was something like a pan, formed at no great distance below the surface, which made it extremely difficult for the roots to penetrate, and so they were unable to bear even a slight drought.

Brigade-Surgeon PRINGLE said that too much irrigation water was infinitely worse than too little, because, while next year corrected the errors of the last, it often took years to remove those of the first. The question of cattle supply was a very serious one; and if he were asked to name the greatest obstacle to the spread of cultivation, and how to remove it, he should say, supply cheap bullocks. The class of animals now used in the North-West Provinces was too often really unfit for work; and, as a sanitary officer, he stated that his inspection of slaughter-houses clearly proved that the mode of selecting the animals to supply the beef for British troops was most objectionable, and that, coupled with the total absence of veterinary treatment, this was, in his opinion, the chief cause of the great rise in the price of bullocks, and that unless some steps were taken to check this, the obstacle of cheap bullocks would go on increasing. The quality of the seed grain was also an important question. The cultivator had too often to take any seed which the money-lender chose to give him, for the interest wanted was too high to lend the ryot money, and the advance was repaid in quantity more than in quality. One thing Dr. Voelcker had not alluded to, viz., the reason of the very small quantity of straw available for manure, which was due to the custom of burning down often the long stubble on the ground; but he had no hesitation in saying that in this way, unknowingly, they got rid of an enormous amount of most pernicious larvæ, and this was the reason why Indian agriculture, where this was practised, was not visited with the pests, which were found in so many other countries. If there was a hard-worked agriculturist in the world, it was the Indian ryot.

Mr. W. S. SETON-KARR said that some statements in the paper would not apply to Bengal, the Province with which he was best acquainted, except with a little qualification. The two main points no doubt were manure and water. As Sir William Hunter had shown, in many places it was the poverty and not the ignorance of the ryot which prevented him from using manure. With regard to the principal rice crop of Central Bengal, manure was not needed, as the rainfall brought down silt from the higher lands, and the Ganges and its distributaries also brought down an enormous quantity of silt. In Western Bengal the ryots stored water on the tops of the hills in reservoirs, and let the water flow down into the plain below. He had observed, with much regret that, in that part of Bengal, a great deal of land, formerly covered with jungle and forest, had been cleared, but it was not turned up by the plough, so that it was neither one thing nor the other. The scrub remained, but there was not energy enough to convert the ground into arable land. He might add that, with regard to estates brought under the Court of Wards, it was provided that portions of the forest should be reserved. Dr. Voelcker was no doubt judicious in

not entering into the vexed question of land tenures, as they affected the agriculture of India. But he could not sit down without some reference to those agriculturists by whom, with unscientific instruments, the magnificent results alluded to in the paper had been mainly achieved; they were the Jâts of upper India, the cultivating communities, and the tenant-proprietors of Bengal. These men reminded him of that ancient cultivator whom the great Roman poet had seen in Southern Italy, and whom he had described in his own picturesque language as one

> "Cui paaua relicti
> Jugera ruris erant; nec fertilis illa juvencis
> Nec pecori opportuna seges, nec commoda Baccho."

And then he goes on to say that this old man, sowing vegetables, white lilies, vervain, and the edible poppy, was quite as happy as a king—

> "Regum æquabat opes animis serâque revertens
> Nocte domum, dapibus mensas onerabat inemptis."

Dr. G. WATT, C.I.E., quite agreed with Dr. Voelcker that the agriculture of India should be developed from within instead of from without. He had been working at the literature of Indian agriculture, in compiling a dictionary which he was engaged upon, and that one idea he found ran through everything he had to deal with. The contrary system had been tried in every way. In the importation of new crops and improved breeds of cattle and sheep, everything had been tried, and nothing had been left undone except the most important of all, that of making an effort to improve what already existed in the country. It was of no use to import pedigree animals if no effort were made to improve the indigenous stock upon which they were to operate. Whole herds of every kind of sheep, for example, had been imported, and on one occasion the Bombay Government procured several hundred Merino rams and ewes; but not a trace remained of those experiments. And this was entirely the result of no preparation having been made in India to improve the native breed before importing the foreign element. It was the same thing with sugar. More than a century ago the Government was asked to assign land to farmers for the cultivation of sugar upon European principles. This was acceded to, and plantations were opened out in which high-class canes were grown. Shortly afterwards the undertaking was reported a failure. Later on the same proposal was made, and the same effort put forth, and for twenty to thirty years the *Journal of the Agricultural Society of India* may be said to have been filled almost exclusively with reports on sugar-cane cultivation; the only trace that now remains of the plantations and factories are the ruins of the buildings. After a few years, the whole of the imported canes died from disease, whilst alongside of the experimental farms there were indigenous canes of as high a quality as any which could be imported. Only the other day a gentleman came from Java, for the sole purpose of taking Indian canes to that island for cultivation. The same thing had happened with tea. No one was satisfied with the fact that there was tea in India, and thousands of pounds were spent in bringing the tea plant from China. This was done; but in Assam, at least, the China tea is now regarded as the curse of the country. The indigenous plant has been found to be far superior. It was just the same thing with indigo. The industry migrated from Bengal and came back again. The native method of manufacture is actually based on much more scientific principles than the European, though the planters are too self-satisfied to learn from the experience gained from centuries. With cotton, the spirit of importation of foreign stock had proved even more disastrous than with sugar-cane; for the imported stock had not only degenerated, but had lowered the value of the Indian races of that crop. We require, therefore, less foreign importation, and more local knowledge, if we seek to actually improve the agriculture of India. The gains, through imported crops and breeds of animals, do not compensate for the total want of the principle of "self-help."

The CHAIRMAN said the time was now exhausted, but any gentleman who had sent up his name might have an opportunity of putting his remarks in writing. This was a subject in which he had taken great interest himself, and he should be very glad to say something about it, but it was now too late; and he could only conclude by proposing a vote of thanks to Dr. Voelcker. He was sure the report he was about to submit to the Government of India would be of the highest value, showing what they ought to do, and also what they ought to avoid.

The vote of thanks having been carried unanimously,

Dr. VOELCKER, in reply, said it afforded him great satisfaction that his paper had been the means of eliciting so valuable a discussion. The differences of opinion which had been expressed were due, in great measure, to the diversities in the conditions of India. One speaker would refer to a part where the country never suffered from any want of water, whilst another had had more to do with a district where it was the great deficiency. So what was said in the paper was evidently correct, that what would suit one part of the country would not do for another; and this constituted the difficulty that anyone like himself would have in coming to any general conclusion as to how to improve Indian agriculture. If he had erred somewhat on the line of caution, it was, on the whole, the safest side to err upon. It was a great satisfaction to him to know that Lord Reay had done a great deal to remove some difficulties, to which he had alluded in the opening, by means of education, and that progress was being made in Bombay. The cause of agricultural progress lost a great friend when

Lord Reay left India, and the Veterinary and other Departments, had found in him an able and earnest advocate. Sir Steuart Bayley mentioned to him, when in India, some of the difficulties to which allusion had been made. He could only say with regard to the working out of a scheme of "fuel reserves," that the difficulties in Bengal were not those to be met with in Madras, Bombay, and some other parts. To forecast somewhat, he considered the working of village forests was a matter which, while it might at first be taken up by the Government, must, in the end, be carried out by the people themselves; but after a few years of supervision they would come to understand the benefit of these "reserves," and would find their agriculture much improved thereby. He was glad to see Professor Wallace had deserted some of his old friends, and taken up new ones from America, but he was not quite so sanguine as the Professor. The practice of green-manuring had not as yet succeeded in bringing to those fields and experimental farms, on which it had been tried, the wonderful increase of crop which was to supply the extra demand of the increasing population. Without altogether binding himself by the opinion of Mr. Elliott, which he had quoted, he reminded Professor Wallace that no one could say the highest type of agriculture was that pursued when there were millions of people crowded together on the land. This was rather speaking of things as they might be, but the real question was how to deal with things as they were. With regard to silage, he was totally at variance with Professor Wallace, and the military authorities, among others, had come to the conclusion that there was a great deal of money being wasted in making silage, when the sun was—as it generally was—blazing hot, while silage was being made.

The following communications on the subject of the paper, from gentlemen who were unable to join in the discussion, have been received since the meeting:—

General Sir ARTHUR COTTON, K.C.S.I., writes:—Incomparably the greatest point in Indian land produce is water containing fertilising sediment. In Madras the difference between an acre of land of average fertility with such water or without, is either the whole crop of rice, value 40 rupees, as in a year of drought like 1877, or 30 rupees as in years when the rains have not failed. This difference is solely the effect of river-water for any length of time, without any other accessory except the ordinary present cultivation. Land in Tanjore has been thus productive for 200 years, the soil being entirely renewed by the material contained in the river water when in flood. The Godavery district was so far below all other districts in poverty, that a special Commissioner was sent to see what could be done to raise it from its extraordinary state of depression. He recommended irrigation works, which were begun by Lord Tweeddale, and now the district is (at least it was a few years ago, and I suppose is still) ahead of all the districts of India in land revenue. The expenditure has been £1,250,000, and the increase in revenue is some £400,000 a year. In the summer of 1877, when millions died in the adjoining districts, it not only lost none but saved the lives of perhaps a million outside of it. The cost was 18 rupees per acre, including embanking all the rivers, draining the whole delta, and 500 miles of steamboat canal. The river irrigation is 700,000 acres, yielding about 30 rupees more than before, or £2,000,000, and certainly increasing the income of people in all, at least £2,500,000, or 200 per cent. on the outlay in ordinary years, besides securing it from famine as at present. About 3 per cent. of the water of the ten great rivers of India has been thus led out upon the land, watering 9,000,000 acres, so that there is rich water now running to waste, sufficient to water 300,000,000 acres of rice, or 1,200,000,000 of dry grain; and not only to secure the crop by moisture, but to renew the land fully by fertilising materials. Think of this immeasurable treasure of water and manure being lost for want of engineering works. There are yet many millions of acres of alluvial land unwatered; but the upper lands might cost about double what the delta land has cost, or 40 rupees an acre; but this would yield a profit far above what almost any other investment of capital would return, independent of the saving of life. If the millions, now unemployed from want of local rains, were executing great works of irrigation in their own districts, not only would those districts be secured from famines, but the whole population would be placed in a state of prosperity. far beyond any thing now thought of. In the Punjab within the last few years the Government seem to have set themselves in earnest to this great fundamental work. Three million acres are now irrigated, and several great works are in hand. There is also one considerable work in the South of Madras under execution, but only for 100,000 acres, when it might have been so projected as to produce some five times the same results. But everywhere else in India this subject is entirely neglected, or the works have been carried out so as to ensure failure. As for instance in Orissa, where most head works have been constructed commanding some 1,500,000 acres, but the water has been only distributed to some 200,000 acres. Were the head works completed, and the whole delta provided with the works of distribution, &c., 2,000,000 acres would be irrigated with the rich river water, the whole delta would be secured by embankments from river floods, and by drainage canals from rain floods, and provided with steamboat canals, which would make the cost of transit nominal. But I may mention one essential point, which from the report kindly sent me seems to have been entirely lost sight of, of late, viz., the difference between rain and river-water. I see no mention made of this in last year's

reports. There is there a great rainfall, so that if the quality of the water is not considered, the land is in danger of being supplied entirely or almost entirely with rain water, and thus the invaluable treasure of the fertilising materials in the river water lost, after all the expenditure to divert it to the land. The fact is, that where the works are executed the great enemy to be contended with is the rain. During the falls of rain the fields should be kept as empty as possible, and the moment there is a pause in the rains the fields should be filled full of river water. If this is lost sight of, the greater part of the value of the works is lost. I see experiments made as to the comparative value of crop from land under the canals and land dependent entirely upon the local rains, and in the accounts of these nothing whatever is said on this essential point, showing that it is not thought of. The experiment wanted is to try to the uttermost to get rid of the rain water, and keep the land supplied from the canals, and thus see what the full effects of the river water are, so far as can be where the rains are so considerable. There is another part of this subject that I ought to refer to, and that is the storage of water for use in the dry season. It is remarkable that India is entirely without lakes; but, on the other hand, it is equally remarkable for natural basins, that only require narrow outlets, to be closed by embankments, in order to store enormous bodies of water, of which there is a certain amount in the lands above them. One of these is probably without parallel in the world, in the basin of the Toombudra, 1,600 feet above the level of the sea, and so commanding almost the whole Madras Presidency. And several others have been examined and reported on. In Bombay alone have the Government done anything in the way of turning to account the inviting openings. There Colonel Fyfe has constructed several, one an extraordinarily fine work, above Poona, which has a capacity of 200,000,000 cubic yards, and as it will be constantly filling for about five months in the year, while the water is being used, it may supply four or five times its capacity, or 1,000,000,000 cubic yards. The native Governments understood this matter, and there are 80,000 or 100,000 tanks in the Peninsula, but they are almost all defective in not being supplied by the south-west monsoon but only by the local rains, so that when they fail they are useless. If Colonel Fyfe's counsels had been attended to, all the great irrigation works of our Government would have been provided with those stores of water, and their canals kept full all the dry season, providing especially for the cultivation of sugar, as well as improving the river navigations immensely. Thus the Orissa works have one known reservoir of immense capacity available, and, no doubt, many more. The Sone works, also, could thus have been secured for sugar cultivation to any extent. When these two great points are thoroughly taken up by the Government, India will be such a garden as is not now thought of. I am quite satisfied that if the details of agriculture are really attended to also, the most extraordinary results will be obtained, and the produce of land as greatly increased and improved as has been the case in every other branch of human industry without exception, for this point must be kept continually in view, that agriculture alone has undergone no improvement worth mentioning, while everything else, without exception—medicine, navigation, manufacturing of all kinds, &c.—have made the most extraordinary progress.

Surgeon-Lieutenant-Colonel T. H. Hendley, C.I.E., writes:—I listened with extreme interest to Dr. Voelcker's most valuable paper, and especially to that part of it which relates to the connection of sannitation with agriculture. He will be glad to learn that that side of the question was not forgotten at the Congress of Hygiene which was held last year in London. I think Sir W. Moore had something to say on the subject, but in a paper I read in the Indian Section, amongst other relevant observations the following occurs:—"Much of the natural animal manure is lost by the conversion of it into dried cakes for fuel, owing to the scarcity of wood. The women are engaged for many hours every day in preparing it with their own hands, from which results a further evil, viz., that the poor cannot have clean food as long as their wives are compelled to follow this vile practice. A true sanitary reform is, therefore, the extension of forests with the provision of cheap fuel. Here, however, the agriculturist gives further trouble by demanding why his grazing rights are restricted, as they necessarily are by forest reservation. On every hand fresh difficulties spring up." To be of use to the villager, both for fuel and for many purposes connected with his occupations, wood must be within easy reach. Until this is the case, the villager's wife will continue to make *bratties* and defile her husband's food. Fortunately near most villages in Rajputana, *beers*, or small reservations of wood exist, or can be formed, but in crowded districts, such as Sir Steuart Bayley describes, the question is a most difficult one. With reference to native States, I should like to make a few remarks. In Jeypore enormous progress has been made in the extension of tank irrigation. For many years past, under a most enlightened Government, Colonel Jacob has been able to form many artificial lakes for the storage of the rain water, and I know that the land which has been irrigated from them has yielded a very large increase of revenue; and that that able engineer has had the pleasure of seeing many valuable lives preserved by the water which has been made available by his skill, during times of scanty rainfall. The inhabitants of Rajputana have always been fully alive to the necessity of storing water, hence there are many fine lakes in the country which have been formed, chiefly as famine works, by constructing huge embankments across streams, at suitable points in the hills. The one thing on which both nobles and ryots in Rajputana

seem to be agreed is the determination to get all they can out of the soil; and they are ready to adopt any improvements, provided it does not involve too great change, and they can thoroughly understand it. Dr. Voelcker's remarks on the treatment of cattle are most instructive. Sometime ago I placed copies of a popular manual on cattle diseases, which was drawn up by the Indian Government of Revenue and Agriculture, in all the dispensaries under my care, and instructed the hospital assistants to read them to the ryots, and to help them whenever possible. The results have been most gratifying, as I have been frequently informed that valuable animals have been saved by the timely advice received. In such ways different departments can assist each other, and all can see that they are working for the common good.

Mr. H. C. Hill (Conservator of Forests in India) writes:—Dr. Voelcker has very correctly said that the Forest Department in the early days had no agricultural object in view. Its objects were, and still are, mainly sylvicultural; at the same time it must be admitted that for many years in certain places, and in Ajmere, Merwarra particularly, the entire strength of the Forest Department has been devoted to the production of grass and fuel on the borders of cultivation. Dr. Voelcker now recommends that forests, under the name of fuel reserves or village forests, should be more generally created and preserved near to cultivated lands, in short, that what has been done in Ajmere should be extended to other provinces. The only difficulty in giving effect to Dr. Voelcker's proposals lies in the fact that such lands as would answer the purpose are no longer at the disposal of Government, and must be bought or acquired in a costly manner. In Ajmere the fertile plain is intersected with a network of bare, rocky hills, totally unfitted for cultivation, and admirably adapted for the production of grass and firewood. It was an easy matter to take up and preserve these, but the rich plains of the North-West Provinces, for instance, have no such sterile, well-defined uplands, and the *usar* lands are so interspersed with cultivation that they could not be separately demarcated and controlled, and the reservation of compact areas would necessitate the inclusion of some cultivable land of high value. The question at once arises, Is the State justified in expending large sums for the indirect benefits Dr. Voelcker sets forth, viz., in order to guard against the deterioration of the soil, and in order to maintain the Land Revenue? Admitting that experts correctly foretell a steady deterioration of soil and a falling off in revenue, the evidence of past years at least demonstrates that the process is extremely slow, and I venture to think that until the agriculturist has been taught to feel that wood is a need, and that in paying for firewood and using cow-dung as manure for his fields he is making a good investment, there is but little prospect of land being acquired and set apart to supply that need. When once the cultivator demands wood, there will be no difficulty in elaborating financially sound plans for its production, wherever water is sufficient. It is, we all know, quite impossible to grow wood without water, from some source or other. I do not anticipate that the management of such forest tracts as Dr. Voelcker contemplates would entail any expensive management, or that the scheme would collapse from the costliness of forest experts referred to by Sir Steuart Bayley. There is one other point to which I should like to refer. I think it is not generally understood that every reserve, every State tract, is a fuel reserve, in the sense that it is quite impossible to grow large timber, either teak, deodar, or sal, without, at the same time, producing in the branches and in trees of inferior kinds a mass of firewood, which is many times in excess of the requirements of the cultivators living around the forests within that radius, to which so cheap a commodity can be carried. It is quite possible that, on certain rocky, poor soils, with limited rainfall, only grass and scrub, such as would meet agricultural needs, can be grown; but it is equally certain that the high forests on richer soils meet the same natural requirements quite as fully, while yielding the more valuable larger timber. In conclusion, I consider we are indebted to Dr. Voelcker for reminding us that the preservation of forest areas nearer to cultivation than, as a rule, they exist, is to be aimed at; and I am confident that his recommendations will bear fruit.

Mr. John Hughes (Consulting Analyst to the Ceylon Planters' Association, 79, Mark-lane, E.C.), writes:—Of the several points raised by Dr. Voelcker's paper, perhaps the most important was the much debated practice of burning cow-dung cakes, or *bratties*, as fuel. This practice is undoubtedly a waste of valuable manure to a certain extent, but it has grown into a custom in the neighbourhood of towns from necessity and not from choice, and is therefore excusable under present circumstances. Indeed, if the ashes of these *bratties* were carefully and systematically returned to the land, the practice is after all not so wasteful as might be supposed. According to my own analyses made some years since, and referred to in the *Journal of the Society of Arts* for March 21st, 1890, one ton of sun dried *bratties* contained the important plant food constituents in the following proportions:—

Lime	43 lbs.
Nitrogen	33 ,,
Potash	14 ,,
Phosphoric acid	12 ,,
	102 lbs.

When such a manure is burned as fuel, the nitrogen, which exists in the form of organic matter, becomes converted into gaseous products, which are either absorbed from the air by growing crops, or brought

down by the rain and absorbed by the soil for future plant food. Therefore, this supposed loss of nitrogen does not occur to the full extent generally supposed, while the whole of the mineral salts, which include the lime, potash, and phosphoric acid, remain in the ashes, and, under proper sanitary arrangements, should be carted out on to the land. It should be remembered that, in round numbers, 80 per cent. of the atmosphere consists of nitrogen in a free form, and that recent scientific research has clearly demonstrated that leguminous plants, such as clover, peas, beans, &c., have the natural property of absorbing this nitrogen and yielding a large crop of albuminous fodder, while the soil, by reason of increased development of root growth, is left richer, and better able to produce other crops. What leguminous crops, therefore, are specially able to do, other crops may be able to do to a smaller extent, so that, in a tropical climate, nitrogen may be the constituent most easily obtained by natural means, and therefore the artificial supply, in the form of manure, is the less necessary. Indeed, the general custom of burning the stubble and destroying by fire the nitrogenous organic matter contained in the straw, clearly indicates that, in India at least, the soils are not specially in need of nitrogen. In our more temperate climate such a practice would be regarded as unnecessary and wasteful, though at times, and on certain soils which have accumulated too much humus and are also somewhat stiff, it is usual to pare and burn the turf; and the late distinguished chemist, Dr. Augustus [illegible] (the father of the lecturer), specially comm[illegible]t as a sound agricultural operation, pointing [illegible] that inert vegetable matter was converted by pa[illegible] and burning into highly effective plant food. Further, that the beneficial effects of a fair quantity of vegetable ashes upon root crops, on certain soils, are more striking than the effects produced by guano superphosphate and other artificial manures. In conclusion, it may be pointed out that India has produced crops of corn, rice, and grain for centuries with apparently but little loss of permanent fertility in the soil, and the fact that some 40,000 to 50,000 tons of boxes are now being exported annually to Europe, certainly suggests the idea to practical men that there cannot be any great demand in India for one of the best and most lasting fertilizers.

Mr. H. J. ELWES, writes:—After so many men of great official eminence and life-long Indian experience have spoken, there is not much left to be said by one like myself, whose knowledge of the country, through spread over twenty-two years, has never been continuous. I must, however, remark on one point which Dr. Voelcker has not mentioned, and that is the little interest which seems to be taken in agriculture by Government officials generally, and native gentlemen and landowners. Instead of being, as in England, an occupation in which the Royal family, landowners, and men of rank take a lively personal interest, it is in India an occupation for humble ryots, and in consequence it is more or less neglected and despised. Of the numerous Indian students who come to the Royal Agricultural College, I have only known one who came on his own account to learn what ought to be a necessary branch of education for men whose living is derived from agricultural rents, as I also think it should be for Indian civilians generally. The remainder were merely qualifying themselves for official positions. As long as agriculture was looked down on in this way in Europe, it remained in a primitive state, and nothing will tend so much to its improvement in India as the example which might be set by native gentlemen improving their own estates and the position of their own tenants. I most fully concur with what Sir S. Bayley said as to the great number of ill-bred and half-starved cattle which infest Bengal and Assam, and which are often unable, from weakness, to do any work. Half, or one-third the number, if better fed and looked after, would be of greater value; but the climate and soil of Eastern Bengal is very unsuitable to the development of either a fine race of cattle or men, and the Bengali is usually the worst beast master of any race I have seen in Europe, Asia, or America. I cannot at all agree with Dr. Voelcker as to silage being unsuited to the country. On the contrary, I believe the system, when thoroughly understood, would afford a constant supply of wholesome food to cattle, which are now systematically starved in the dry season; and the coarse nature of most native grasses seems to make them much better adapted to silage than to hay. But it requires very long practical experience to make good silage, and to know how to use it to the best advantage. After twelve years of personal attention to the art in England, I am only now beginning to think I know something about it. And yet the system has been often condemned on account of the failure of persons whose only knowledge was gathered from books or chemical experiments. In Indian agriculture, as in English, practice must come before science; and what Dr. Watt has told us to-day, does not in the least surprise me, after seeing, in many parts of India, the most foolish and unpractical attempts made to carry out European agricultural practices by persons who, however able in other ways, had no practical knowledge of agriculture. Schoolmasters will never be able to teach agriculture, or to get farmers to listen to their advice, either in England or India, unless they have a personal practical acquaintance with the numerous difficulties, which so often make it impossible to carry out scientific agricultural principles in a profitable manner. The best farmer is not the man who produces the largest result, but the one who shows the best balance of profit. With regard to green manuring, as a cheap means of supplying nitrogen, I think Prof. Wallace is rather too sanguine, and would much prefer, where clover or other leguminous crops can be grown in India to turn them into good cattle

food, and thus supply manure. Perhaps the most difficult of all the questions which have been raised is the supply of fuel and grazing, and this is essentially one which can best be dealt with on large hereditary estates, where the owner not only knows but cares for the wants of the people, and the system of management is continuous. No forest department, however large or however able, can deal with such a question as this; but resident landowners can, and would do it, if it was fashionable and profitable to plant trees as in Europe.

Mr. W. SOWERBY writes:—There are a few points upon which more information might have been given. There is, for example, nothing whatever said about the possibility of obtaining in India mineral manures, such as lime, phosphates, nitrates, &c. Every country in the world has been ransacked to obtain these valuable fertilizers, but nothing whatever has ever been done in India to find such useful minerals. The evil effects of denuding forests not only in India, but in every other country, and the beneficial effects of conserving them, goes without saying; but whether the growth of wood for fuel to prevent the natives from burning cattle manures can be effectively carried out is a difficult question; for the carriage of such wood fuel to any great distance, unless by cheap water carriage, would make the fuel more costly than it was worth. There are no doubt in India many undeveloped coal fields which should afford great supplies of fuel.

General MICHAEL writes:—Sir Steuart Bayley, in his speech, questioned the practicability of the Government being able to acquire land readily for village fuel reserves. I don't know how this may be in Bengal, but in Madras there would, I believe, be little difficulty. Lord Reay, who sat next to me at the meeting, told me that he thought there would be no difficulty in many parts of Bombay.

Miscellaneous.

MOSCOW CONGRESSES.

The *Société Impériale d'Histoire Naturelle d'Anthropologie et d'Ethnographie* is making arrangements for the holding of two International Congresses, one of Prehistoric Anthropology and Archæology, and one of Zoology, at Moscow, in August next. The following letter to the Secretary of State for Foreign Affairs, from the Russian Ambassador in London, has been received from the Foreign-office, through the Science and Art Department:—

Londres, le 18/30 Mars, 1892.

Monsieur le Marquis,—

Le Ministère de l'Instruction Publique vient de m'informer que la Société Impériale d'Histoire Naturelle, d'Anthropologie et d'Ethnographie se proposait d'organiser dans le courant de l'été prochain deux Congrès Internationaux, d'Anthropologie Préhistorique et d'Archéologie, et de Zoologie, dont le premier doit siéger à partir du 1/13 au 8/20 Août, et le second, du 10/22 au 18/30 Août.

Le Gouvernement Impérial étant trés désireux de s'assurer la participation des savants Anglais à ces réunions scientifiques, a chargé l'Ambassade de recueillir les souscriptions et de délivrer les reçus, dans le but de faciliter à ceux d'entr'eux qui voudraient se rendre à Moscow, le versement de la cotisation, dont le montant est de 20 frcs. pour l'un des congrès et de 30 frcs. pour les deux.

En portant cette invitation à la connaissance de votre Excellence, avec la priére de lui donner la publicité qu'elle jugera convenable, je crois devoir ajouter que le Consul Général de Russie à Londres a, de son côté, pris des mesures pour en informer directement les sociétés suivantes:—

1. British Association for the Advancement of Science.
2. Society of Biblical Archæology.
3. The Anthropological Institute of Great Britain and Ireland.
4. British Archæological Association.
5. The Archæological Society.
6. The Royal Society.
7. The Zoological Society.

J'ai l'honneur d'être, avec la plus haute considération, Monsieur le Marquis, de votre Excellence le très [illegible] très obéissant serviteur.

(Signed) STAAL.

A S. E. le Marquis de Salisbury, K.G.

BOOK TRADES' EXHIBITION IN AMSTERDAM.

Information has been received from the Foreign Office, through the Science and Art Department, that an International Book Trades' Exhibition will be held in the Palais de l'Industrie at Amsterdam, in July and August, 1892. The Exhibition is arranged by the Librairie Néerlandaise, which thus celebrates the seventy-fifth year of its existence. The heads of classification are as follows:—Group A. Books of the present time in all forms, music, journals, and maps; B. Printing, type founding, inks, woodcutting, &c.; C. Copper and steel engraving, etching; D. Lithography; E. Reproduction processes by means of photography; F. Binding, leather and other materials; G. Paper; H. Account books, almanacs, letter paper, pens, pencils, &c.; I. Libraries, shelving, book plates, &c.; K. Retrospective exhibition.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, APRIL 22, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

The Royal Commission are now able to announce that, her Majesty's Government having increased the grant placed at their disposal for the purposes of the British Section, from £25,000 to £60,000, they can dispense with any charges for space at the Exhibition, and will return to the intending exhibitors the amounts already paid on that account.

The available space in the General Manufactures Building is now almost entirely filled. Exhibitors in this department should therefore lose no time in applying.

In the Agricultural Building, and in the Machinery Building, space is still available.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

FISHERIES DEPARTMENT.

The following communication has been received from Mr. J. W. Collins, Chief of the Fisheries Department of the Exhibition :—

Sir Henry Trueman Wood, Secretary Royal Commission, Chicago Exposition.

Dear Sir,—I have the honour to enclose herewith, for your information, copy of circular letter that I have recently forwarded to various people throughout Great Britain, who are interested in the fisheries, with the hope of securing their co-operation and interest in making a thorough display of the British fisheries at the World's Columbian Exposition.

Yours very truly,

J. W. Collins,

Chief, Department of Fish and Fisheries.

I have the honour to respectfully represent to you, that, in accordance with the official classification of the World's Columbian Exposition, there has been created a "Department of Fish and Fisheries," and that there will be erected a group of buildings especially constructed for the accommodation of exhibits of fish, fisheries, and fish culture.

It is my present purpose in writing chiefly to show what has already been accomplished, and to state certain facts that, perhaps, have not been previously brought to your notice, or fully elucidated.

1. The fisheries buildings are practically completed. They will fully meet the requirements for which they have been erected. It is conceded on all sides that they are not only wonderfully beautiful and harmonious in arrangement, from an architectural standpoint, but that they are peculiarly well adapted to the needs of a fisheries exposition. It is, therefore, easy to arrange the exhibits in separate buildings under general groups—aquaria, commercial fisheries and fish culture, and angling.

2. Space will be awarded, free of cost, to applicants who desire to exhibit.

3. As is usual at expositions, awards will be made by competent juries.

4. The management are in negotiation with the transportation agencies as to rates, and the most favourable terms are expected; already important concessions have been made, and every facility will be accorded displays sent from foreign countries.

5. The Columbian Exposition offers to exhibitors exceptional opportunities for bringing prominently to the notice of the world the business in which they are engaged.

6. Material intended only for exhibition will not be subject to customs duties, like ordinary imports.

It is believed that a large and instructive exhibit, such as will be brought together at the Columbian Exposition, will not only promote trade interests, but will aid materially in securing recognition for the fisheries, and tend to enhance their prosperity and development.

Reservation of space in this Department has been tentatively made for the instalment of exhibits from your country, and it is expected that the British fishing interests will see the advantage of sending collections that will fairly illustrate their trade.

Blank forms of application for space and other data of interest to intending exhibitors can be secured by addressing the Secretary of the Royal Commission appointed from your country, Sir Henry T. Wood, Society of Arts, John-street, Adelphi, London.

In conclusion, it is proper to state that the regulations of the Exposition require that all foreign Commissioners shall report, not later than November 1st 1892, the amount of space necessary to accommodate exhibits from their respective countries. It is therefore needless to say that this matter should receive the prompt attention of intending exhibitors, in order that they might not be deprived of any advantage.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 12th, 1892; Lord MASHAM in the chair.

The paper read was—

ENGLISH BROCADES AND FIGURED SILKS

By C. PURDON CLARKE, C.I.E.

The subject of my paper being restricted to those varieties of woven silk known as damask, brocade, and brocatelle, it is unnecessary for me to instance the many proofs of the great antiquity of silk culture, and of the manufacture of plain woven silk fabrics. We can concede the claim to its origin to China, where, it is related, twenty-six centuries before Christ, the rearing of the silkworm was the pastime of royalty; and the Empress Cse-ling-she is credited with the invention of the first loom. Whether that loom was for plain weaving, or capable of producing figured stuffs, we are not informed; but it is probable that 1,000 or perhaps 2,000 years elapsed before the draw-loom developed sufficiently to produce the ancient examples recently found in Egypt. It is true that early writers describe woven stuffs, rich in pattern, like that which Homer gives to Ulysses, where a decorative hunting subject, interwoven with a gold ground, presents to the mind's eye a garment not unlike a *shikargah*, or hunting ground pattern of Benares or Ahmedabad; yet the weight of probability is in favour of such fabrics having been figured either by hand embroidery, or woven in a tapestry loom, between which and the simplest form of figure weaving loom there s a gulf which must have taken many centuries to bridge.

The difference between these two methods of weaving is great, and yet so little known, even to many whose connection with the arts leads them to continually mention, and often to confuse, the two under one name, that a short description of both these processes is necessary.

In true weaving, whether of silk or other fabrics, the loom is a framework carrying the warp or threads which run the long way of the stuff, and the whole process of weaving consists in working a transverse thread—the weft or shute—which, passing alternately over and under the threads of the warp, forms the structure of the fabric. It is probable that, in the first looms, the needle was employed to carry the thread for this purpose, and this needle, working laboriously in and out each warp thread, produced a coarse fabric at a slow rate, and of very uneven texture. Then came the invention of the heddle harness and reed, in which, by pulling a string or pressing a lever with the foot, alternate sets of warp threads were raised or depressed, and the needle, becoming a shuttle, shot the whole width of the stuff at one operation in less time than it took before to turn round a single warp thread. The earlier process had been as simple as basket-making or, at the utmost, the plait of a straw mat; but now the true loom was started, and soon, by increasing the number of heddles, and changing the sequence of the alternation of warps, diagonal, chevron, and diaper patterns were formed, and, gradually, more complicated figures produced.

The tapestry-loom is the primitive form of the machine, and, as it was 3,000 years since, so it is to-day, whether working at the Gobelins or in Asia Minor and Persia—where the *kehlim* carpet and curtain is the product of the same loom, and made in the same manner. In this we have the frame and warp threads, but there is no through weft, excepting where a single stripe of pattern crosses the whole width of the stuff. The process of manufacture is very simple, the pattern being produced by interweaving by hand, the various coloured threads in a manner similar to the making of a basket, and as the needle carrying each colour, after travelling its width has to return along a parallel path wherever a difference of colours occurs in a straight line in the direction of the warp, there is no connection between it and the next colour, leaving open slits in the stuff in wall tapestries — where such lines, in architectural subjects, are of frequent occurrence—an amount of sewing has to be performed to hide this defect in the weaving. For this reason the *kehlims* of Syria and the *dhurris* of India have no lines in the direction of the warp, but form patterns in zig-zag.

The hand-made carpet looms of the East, and the shawl looms of Cashmere, are half-way between the tapestry and the figure-weaving loom. Like the tapestry, the pattern is worked in and out by hand; but they are true looms in having heddles to separate the warp-threads, and shuttles to throw a weft-thread, which in this case—hidden beneath the pattern—serves to bind the fabric together.

We can only conjecture respecting the class of woven fabrics described in the Odyssey and

the Iliad, but we can now speak with positive certainty of the looms as far back as the second century, owing to a valuable find of early stuffs at Akhmim, in Egypt—from which a large and valuable collection can be seen in the South Kensington Museum. Here we have weaving in a state of perfection which has been little improved upon in our days, and each type of loom work is well represented in this collection. Amongst these fabrics are some which are the earliest examples of brocade weaving yet found, representing the period commencing with the Ptolemaic dynasty, and ending only after the Saracen conquest of Egypt.

Then, in our own England, the dresses which, at the beginning of this century, were found enveloping the body of St. Cuthbert, at Durham, add a 10th century link to our chain of examples. These stuffs were probably the work of Saracen settlers in Sicily. An examination of this series of brocades shows that, even at this early period, a whole system of mechanical weaving was practised; and it is this that should be clearly understood, and not in any way confounded with the weaving of tapestry work.

In the early figure looms, only geometrical figures with small repeats were worked, but, as the patterns grew fuller in design, the system of heddles and harness a series of strings and levers, had so complicated the loom, that it became impossible for the weaver to remember the right sequence of changes in shuttle and lever, and then an elaborate system for the transfer of a drawn pattern to a pedal and shuttle notation became necessary; and the weaver merely performed mechanical duties, whilst the actual artistic work was done by the mounter of the loom, before a single throw of the shuttle was made.

An example of the weavers' notation is here to-night, and it is absolutely certain that a similar system was used in a piece of Damascus brocade, found at Akhmim, from a trifling error in each repeat, which could only be due to an error in the notation.

Having traced the figure-weaving loom back at least to the second century, I must now speak of its introduction into England, and about this can only say that the date is still very uncertain. It is not an industry suited to small production, and by no means a village craft, capable of being carried on by single artisans in their own homes. At the present time as much as several hundred pounds—after three or four months' work of men in several branches of trade—is required before a silk hand-loom can be set in working order, to produce some of the brocades exhibited here to-night, even in one of the humble dwellings of a Spitalfield weaver, who is the owner of the loom-frame only, and not of the jacquard or mounting; and in India, to this day, the people who set up a loom for the weaver of *kincob* take 45 per cent. of the gross selling price of the material for their labour. The system by which such a costly trade could be carried on by artisans in their own homes is, as I have already stated, by the means of capitalists, who, in old times, were often the retailers.

As purely an article of luxury, a knowledge of the fashion of the period is all important in commanding a sale for the production, and as no weaver could undertake the risk of weaving a design unless sure of a sale, the capitalist became the actual manufacturer, and the weaver little more than a part of the mechanism of the loom and, paid by the piece, was well rewarded when he joined industry to dexterity. It was only at the commencement of direct European trade with the Indies, and the introduction of silk culture to Italy and France, that the lowered price of the raw material enabled it to be imported in sufficient quantity, and then silk-weaving became a leading industry in France, and was afterwards introduced into England, but was only established as an important manufacture in this country upon the immigration of the Flemish weavers in the 16th century. It was at this time that we begin to find considerable records of figure loom weaving, amongst which is the grant of a Charter by Queen Elizabeth, in 1564, to the Dutch and Wallon settlers in Norwich.

Three hundred families of these refugees were settled there by the Duke of Norfolk, and, with other trades, they introduced damask, flowered and striped silk weaving. A hundred years later, the revocation of the Edict of Nantes strengthened our silk trade by the expatriation of a large number of French weavers, and to these is attributed the foundation of the silk industry of Spitalfields. The Flemish and Huguenot weavers formed settlements in various parts of the country, and besides London, Kent, Essex, and Norfolk became seats of manufacture, whilst others in fewer numbers, migrated north and west. Several of these remain unchanged, and Spitalfields still takes the first place in the country for hand-loom work, whilst the figure-looms of Canterbury and Norwich have ceased to work, the latter having, early in the century,

rivalled and even excelled the shawl weaving of Cashmere. The figured ribbon manufacture at Coventry has survived many vicissitudes, whilst Macclesfield, starting with a lighter class of fabrics, is becoming a centre which will eventually furnish dress and furniture silks equalling those of the southern factories. Nor ought I to forget to mention the hand-looms at Leek, the power-looms of Halifax, Patricroft, near Machester, Glasgow, and other rising places in the north—the great mechanical country—where the future of silk will probably be secured. The looms used by the early weavers remained unchanged until the beginning of the present century, when an ingenious Frenchman sent to a Workmen's Exhibition, at Paris, a machine for simplifying net and ribbon weaving. Through the advice of General Carnot, the grandfather of the present President of the French Republic, Napoleon I. instructed this workman to attempt the application of his invention to the draw-loom, which had been already improved by Vaucanson fifty years earlier. The great mechanical genius of Jacquard was equal to the task, and the overgrown complication of the draw-loom and its attendant boys became simplified, and by adapting the fly-shuttle—which had been used in England fifty years earlier—labour in producing wide stuffs was reduced to a minimum. By Jacquard's system the machine automatically read the pattern notation, instead of having it read by the draw-boys, and so perfect is this loom that, although power looms will produce the bulk of brocade and damask in the future, the hand-worked Jacquard loom, in its present form, will probably always remain as the handiest for the higher class work.

This manufacture, so wide-spread for a time, did well, and until the treaty of 1860 opened the market to the competition of foreign producers, a large population was comfortably maintained by the practice of this beautiful art. In 1825, London possessed over 24,000 looms, employing 60,000 hands; but after a few years of free trading, the number of looms dropped to 1,200, and the weavers to 4,000. A few years before 1860 our imports of foreign silks were but £2,365,415. In 1889, they had grown to £11,000,000; and it is to secure again to our wage-earning population a large proportion of the enormous sum which annually is thus sent abroad, that our best endeavours are needed.

It would be of great assistance to this good work if it was possible to dispel the misconceptions and prejudices now retarding a natural development, which may rival that of the great cotton manufactures of Lancashire early in the present century. The first of these is that the English silk is dearer than the French, and this is so wide-spread that even our manufacturers share it with the public. The brocades and figured silks you see here to-night cannot be made and sold by either France or Germany at the price that these are sold for; imitations can, and to explain this I must refer to an unpleasant matter, but one which is of vital importance, not only to our manufacturers, who lose the trade, but to the buyers of the foreign substitute by which our goods are undersold. To render silk capable of being dyed, certain operations of scouring and washing have to be gone through, and these result in a loss of weight of as much as one-fourth; therefore, a skein weighing 16 ozs., after dyeing, is returned to the weaver with only a weight of 12 ozs. To make up for this loss, it was the practice to use certain chemical substances, which, actually combining with the silk, took up the dye, and, for a time, the weavers were content to receive back their skeins without much loss of weight. Rival dyers, however, soon competed with each other in increasing the weight and substance of the silk yarn, and, by leaps and bounds, in black silks, this increase went on, till 16 oz. of silk was returned by the dyer, weighing 36 oz., then 50, and, eventually, 100 oz. For a long time, only black silk would bear this load, but the discovery of the use of salts of tin enabled the dyers to apply it to other tints; and the French, who have always shown great cleverness in applying chemistry to the arts, turned the process to such profit, that they are almost able to dispense with the raw material. By the adoption of these and other silk substitutes, the foreign manufacturers are enabled to produce fabrics which, sold as silk, make our dress and furniture stuffs appear dear in comparison; but, when we insist upon having the same quality in pure silk, fast dyes, and close weaving, then our own productions beat the foreigner's in price, and will, I trust, before long, in design also.

Another prejudice is, that for beauty of design, we must always remain inferior to the French. This leads me to place before you a problem. I have recently had to compare French and English weavers' pattern-books, dating from 1750 to the present time, and I found periods when there was no difference in quality, and

then, both running off, apparently in rivalry, in an endeavour to produce the crudest colouring and most vulgar designs the mind of man could imagine. In these the French, with their superior daring, especially in wrong-doing, excelled, and the patterns of the time of Louis Philippe were even worse than ours. With the second Empire, however, they went ahead, and although we followed closely, it was but following, except where original paths were struck out by irrepressible genius, and our manufacturers—or rather the middlemen who dictate to them—were forced by public approval to turn from France and unwillingly submit to the dictum of an English designer. Thus Owen Jones, in the "fifties," tried to free ornament from the restraints imposed by the attempted representation of natural objects. His work was beautiful, but it was the beauty of a snow crystal—wanting in human interest. Then Dr. Dresser, who, at first following in the same path, re-admitted natural forms, and was one of the first who showed British manufacturers in many trades that the public would accept and pay good prices for original English designing. But the great change came as a tidal wave; and it would be doing injustice to many, if I attempted even to give the leading names of our artist designers of the past 20 years. Nor does time permit me to even sketch the strong influence of Japanese and Persian art, and the result of the flooding of our markets with the textile treasures of Turkey, after the war of 1887. All these have helped to enlarge our ideas on the beautiful in Art, and to free us from the forcible adherence to a few fixed and often lifeless styles. It is in this path that we owe so much to the the great and beneficial influence of the work of William Morris, in silk, as well as in many other classes of applied decorative design; and it will be only when the history of this century comes to be written, that the greatness of this work will be more evident and better understood than it seems to us at present, especially when the importance of the social and economic principles involved will be acknowledged, and an art, ennobled and elevated, will stand clear from foreign styles of design which often, at their most prosperous periods, were associated with vicious and rotten conditions of society, as false as their own art principles.

There is another disability from which the trade suffers, in its competition with the foreign producer, that is, the evasion of taxation by the foreign goods, and this to an extent which is so considerable that, if the Chancellor of the Exchequer could only devise means to prevent what is actually a gross fraud, not only would the competition be weakened, but our revenue would be strengthened, probably to the extent of some millions. The Spitalfields loom-master not only has to bear the whole brunt of imperial and municipal taxation in his factory in the East-end of London, but again in his city office. He has, in addition to the cost of an extensive establishment, to pay his full taxes, and also the income tax on his profits in many cases in such a manner that although one business, he is practically paying taxes twice over. I am informed that business to the extent of many millions per annum is carried on in the City of London, and the leading commercial cities, by agents of foreign houses, who pay diminutive rents for small offices, do all their business with samples, keep no books, receive no payments in England, and only pay income-tax on a fixed salary. In some cases these people are suspected of being partners of a foreign house; their share of profits is not declared, but accumulates in their own country until, after some years of successful trading, they return to it. This not only applies to the silk trade but to many others; in fact there are few trades in the City where these foreign agents do not swarm and carry on business, receiving the benefit of our protection in all parts of the world, whilst they practically evade sharing in the cost of the Empire, which falls so heavily upon our own people.

Another misconception is that hand-woven silks must necessarily be so much more expensive than those produced in the power-loom. Actually, in high-class work, the difference is not so great, as, in both, the cost of the raw material and the setting of the pattern in the loom remain the same, and these, unfortunately for the weaver, are the principal items in the value of a yard of silk. With respect to the power-loom, the work produced by it differs very little from hand work, as each loom is attended by an experienced weaver, who, whilst giving the same watchful attention, is saved the heavy labour with the foot-pedal which is a common source of permanent injury to many.

As I have already shown, the beauty of the pattern does not depend on the weaver, his duty being solely to perform certain actions which require vigilance of eye and dexterity of hand, but little thought. The softness, or rather looseness, of some hand-produced goods can equally be obtained in power-weaving, but this quality, dear to artists, is not regarded by the

manufacturer in the same light. The hand-woven linen fabrics—some named after our greatest art critic, which are selling at prices equal to silk—could equally be produced by power; and many of the old Venetian and Turkish brocades are the result of work so bad that a power-loom would have to be out of order to perform it, and the yarn not regularly spun by perfect machinery, or even a trained hand-spinner, but twisted somehow from a distaff from imperfectly prepared fibre.

Before commencing the notice of the examples of silks kindly lent by different manufacturers to illustrate my paper, I must mention a source of strength, especially in the matter of design, and that is the practice of engaging looms, either in factories or at the homes of the weavers, by the leading furnishing and decorating houses. This has, in recent years, done much to remove the reproach of producing stuffs artistically inferior to the French. Charged with the decoration of palaces and the houses of the wealthy, these firms—forced to seek beyond the stock patterns of ordinary commerce—have, therefore, engaged the assistance of skilled artists and designers to produce patterns which, to a great extent under their own personal superintendence, were put on the looms, and carried to a perfection the maker for the general market could not afford to attain. Although the copyrights of these designs were generally secured to their owners, yet the influence spread, to the general benefit of all concerned. Some of the principal amongst these firms have lent examples of these engaged silk patterns, and a description of these will be given in their turn.

This system of engaged patterns is but a development of the old custom of engaged looms; and I am informed that the bulk of the so-called manufacturers in Lyons, do not actually possess a single machine, but, free from the heavy strain of capital sunk in machinery and rents of large factories, devote their energy and capital to negociation, first, of the designs and the purchase, dyeing and preparation of raw material, then the disposal of the goods when made.

In attempting a description of the figured silks I have to congratulate my audience and myself that I resisted the proposal to include other classes of English silken fabrics with brocades and figured silks, as no evening would have sufficed for the purpose. Indeed, I feel that the few lines of notice, which is all that my space permits, to a small selection of typical examples, is not in any way fair to the lenders of art works, which have cost them something more than time and money. In several cases I collected sufficient materials for a good monograph in the history of a single factory; and my hope is, that this poor effort of mine will bring in separate papers on different localities, many of which will repay the explorer, by their richness in old world memories, whilst up to date in practical working.

Beginning with Spitalfields, where the hand-loom factory of Messrs. Warner and Co. is one of the largest and most important. Amongst their silks will be noticed a large cloth of gold brocade—a veritable Indian *kincob*—the order coming from India, where it is impossible to hand weave stuff of such great width. The next is a damask pattern, designed by Owen Jones 30 years back, the following details of the manufacture of which, I think, will prove interesting. This fabric is woven in a hand-loom controlled by three Jacquard machines, requiring a *mounture* and harness, consisting of 29,088 threads in the width of 63 inches. Every one of these threads has a work to perform in forming the pattern, and, in the mounting of the loom, has been attached by a small glass pulley to one of the warp threads. The warp used in this piece of 60 yards used up 1,022 miles of silk thread, and, in addition, 757 miles of silk was consumed in the weft. Each of these warp and weft threads consists of 15 fine threads as produced by the worm — thus the piece contains 26,355 miles of silk as rolled off the cocoon, requiring about 100,000 cocoons to produce this quantity. The lengths of the repeat in the design is 28 inches, and in consequence of the fineness of the texture of the material, 9,312 perforated cards had to be cut. These cards are laced to form an endless band, and measure 1,000 yards in length and weigh 5½ cwt. The whole pack of cards has to be turned over each time the 28 inches of design is woven, each card taking its turn singly against the needles in face of the Jacquard cylinder, so raising and depressing the threads of warp, thus causing the openings through which the shuttle passes. This small pattern, only 28 inches long, required to be placed on ruled paper, sufficiently large to show visibly each thread. This measures 16 feet by 9 feet 3 inches, and contains 5,587,000 small squares.

Messrs. Collinson and Lock show some Spitalfields silk, which cannot be rivalled for beauty of design or technical excellence of

manufacture. The Louis XVI. brocade, in silver figure on a rose Du Barry ground, was made for the Palace of Charlottenberg; and the heavy cloth of gold brocade, which glows with the tints of a late autumn sunset, will in a few days grace the walls of a saloon in the Rue de Rivoli. Messrs. Gillow also show valuable reproductions of early 18th century loom work, and can claim an unbroken history of over 200 years' connection with Spitalfields furniture brocade. Messrs. Helbronner are the possessors of many special designs, and besides their Spitalfields productions they employ many hand looms in the old Huguenot settlement at Braintree in Essex.

Liberty's dress silks are well known, and amongst these Spitalfields and Braintree occupy the first place, although, for lighter figured silks, the examples from Macclesfield, Halifax, and Glasgow offer beauty and quality, which no similar foreign silks can equal at the price. Messrs. Debenham and Freebody have never failed to support British made silk, and have used their utmost influence in securing for Spitalfields the orders for the richest court dresses of many seasons past.

Some examples of Messrs. Bailey, Fox, and Co.'s loom work are also shown—figured silks and brocades—and are of equal rank with the higher class Spitalfields manufactures. The other Spitalfields silks, which have been lent to illustrate this paper, include examples from Messrs. Buckingham, Messrs. Burnet, and Messrs. Goodyer, and are instances of the great national characteristic of doing things thoroughly and well, when we properly set about it. Examples of these silks, at the Paris Exhibition of 1889, were challenged by French manufacturers, who refused to believe that they could be produced in England; and, I must own, that I did not feel sufficient confidence to publicly claim such beautiful art works as English, until I had personally seen many of them on the Spitalfields looms; and, looking back through old pattern books over 150 years old, I find that the power to produce these designs had always existed, only waiting for business men, like Mr. Lock, to come and set them on the right path.

Messrs. Walters' Essex factory, at Braintree, combines the Spitalfields hand-loom system with a large steam factory, where power-looms are ready to meet the demands for large quantities in the small limit of time that modern commerce is forced to demand. The damasks include reproductions of old Chinese stuffs, and the brocades for upholstery work are scarcely surpassed by the best French looms. An interesting exhibit from Braintree is the original drawing of a design made by Prince Albert for some hangings for Buckingham-palace, in 1850, since which time Messrs. Walters have woven most of the silken walls there and at Windsor Castle.

Then, further north, the brocades from Messrs. Bermingham, of Leek, a town where silk is the principal industry, and, for dress purposes, the lighter but beautiful silks of Halifax, Macclesfield, and Glasgow, of which specimens have been lent by Messrs. Liberty and Co. I cannot attempt to give the names of more than a selection of manufacturers, and I know that I am doing an injustice to many weavers of brocades and dress stuffs by not mentioning them, especially the beautiful figured poplins formerly called "tabinette," which are made by such makers as Pim, Dunn, and Atkinson, of Dublin. But before leaving these examples, I should like to call your attention to a new direction in figured weaving, shown by samples of loom embroidery from the mills of J. O. Nicholson, of Macclesfield. This suggests infinite developments, and especially merits the attention of artists, as it forms the solitary instance I know of in the whole art of weaving where, without labour or fatigue the artist can direct the pattern, and, "fancy free," transport his thoughts to the stuff almost as easily and as speedily as he could with a brush of colour or a sheet of paper.

It was not my intention, when first taking up this subject, to do more than allude to the past, as the practical question before us is really that of the present and future, and about that future I have no doubt. Although for a period depressed—if not almost completely extinguished—figured silk weaving is not a moribund industry. Its vitality is proved by its present existence after a career of unmerited misfortune, for no other trade ever showed such tenacity of existence as this industry when economical changes made it almost impossible for it to be carried on, except at a loss to all concerned. To assist you to realise the terrible result of the opening of our ports to foreign silks in 1860, the following details are more than sufficient. Before that date the number of looms in five centres of manufacture exceeded 57,000; in the year 1885, these had diminished to 4,400. It may be said that the cheapening of silk has been a boon to at least the female portion of the working classes, but

my own feeling is that they would have been both materially and morally better off if they had remained the makers as well as the wearers of silken goods. Of its importance to us as a nation I need not say more than that France produces over £20,000,000 worth of manufactured silk every year, and exports of that to the value of £15,000,000, a sum which goes far towards paying for her import of corn from other countries. It only requires British energy to be thrown into this matter to enable us to rival and, I trust, excel in every branch of the silk trade as it has in the beautiful plushes and velvets of the Manningham Mill which neither France nor Italy can equal; and the present superiority of France in questions of art is, I think, answered by the display of English designed and woven silks here to-night. When closely examined, this superiority of French art is found to be more apparent than real. Our weak point is that honesty of purpose is always striving after a perfection which is practically unattainable. It is this which renders the designs of our art students so often of little use to the manufacturer, and drives him to either educate his own draughtsman or rely on patterns purchased from abroad. Our students have been so thoroughly well taught the general principles of art and design that, in a manner, they are superior to the narrow requirements of any single trade. They are afloat without direction or purpose, on a sea of experiment, whilst the French designer is safely anchored to his half a dozen orthodox styles. With these he cannot be but safe, and often the only outlet for his energy is the alteration or modification of colour tones in a standard pattern, in order to suit the demands of passing fashion.

There has been of late a good deal of writing and talking about doing something for the silk industries—as if it was a question of charity—and ladies have been asked to show their patriotism by refusing to wear, or use, anything but British made dress silks and furniture brocades, so much so, that the leading ladies in the land have taken up the matter earnestly, and the Ladies Committee of the Silk Association, under the presidency of H.R.H. the Princess Mary, Duchess of Teck, numbers amongst its enthusiastic workers and supporters the leaders of style and fashion; but, unfortunately, in the whole history of trade, we find that something more than an appeal to patriotism is necessary to save from destruction a decaying industry. Fortunately in this case, on every side there is evidence that, instead of failing, it is increasing in importance, and, like our native oak, though slow in growth will be great in maturity.

A step in the right direction has been the formation of the Silk Association of Great Britain, of which Mr. Thomas Wardle is the president; and this is, after all, but the revival of the old system of trade guilds amongst manufacturers for mutual support. In the Middle Ages such a society would be a chartered guild, armed with legal powers, and capable of restraining injudicious competition. But in this 19th century these powers have changed their form, and the Silk Association has broadened its basis by including in its members all those interested in silk, whether producers or distributors, and finally, representatives of the most important class of all the buyers. The Silk Exhibition, a complete success in 1890, was the work of the Ladies' Committee of the Association. Held at the house of Lady Egerton of Tatton, it was successfully carried out by a committee of ladies, who, earnest workers in the two great opposing political parties, sank their differences for a time, and harmoniously together, achieved this great success. In fact, this good feeling of harmony is a characteristic of the silk trade, and, whilst gathering information, I was very much impressed with the kind feeling shown towards each by rival manufacturers. Of this perhaps Mr. Wardle is better entitled to speak than myself, only I cannot refrain from giving testimony to the earnest devotion and unselfish help he has freely given to all classes of silk workers, both before and since the first time I had the pleasure to meet him, when, at the Paris Exhibition of 1878, he practically founded the great industry in the manufacture of "Tussore" silk, in which, I am sorry to say, we have not kept pace with the foreigner, although the raw material is principally supplied from British territory.

Although I have been speaking in defence of machinery, I must admit that my own feeling is against it, as it requires so little human labour, and renders the problem of how to employ our population more and more difficult of solution; yet I cannot but feel that it is inevitable, and, therefore, only wish to see such an increase of trade that the number of people tending the machinery shall more than equal those who now produce the work by hand. One of the causes which will hasten the decay of hand-loom work is the difficulty of finding people to undertake it. The whole tendency of the age is against drudgery of any sort;

and it is only by a long apprenticeship that the hand and eye can be sufficiently trained to produce the fine weaving in the hand-loom. The modern boy will not submit to this apprenticeship. Over-educated for almost any class of manual work in the Board Schools, he is disinclined to take up work where no thinking is required, and to submit to a servitude which, in his opinion, brands him with the reproach of youth, and, in a measure, restricts his freedom. Nor is the effort which is being generally made, and which I see is changing the name of many of our art schools by calling them polytechnics for technical instruction, likely to help in this matter, as the very Act of Parliament which enables the cost of these institutions to be added to our already overburdened taxes, specifies that the practice of a trade shall not be taught, but simply the higher instruction which, when acquired, turns out a possessor of a certificate who has a theoretical knowledge of every part of a trade, but who could not earn a penny loaf by a single day's work with his hands. I am not in any way speaking against our system of technical education as far as it goes, but only wish to warn you that something more than skilful foremen and managers is required, and in my opinion that want was supplied in olden times by the system of apprenticeship.

I have had unusual opportunities of seeing the practice of many arts in various parts of the world, and always noticed that where work was best done was where they thought and talked the least about it. The secret of the woven stuffs of Persia and Cashmere was the five or six years apprenticeship in each branch of the craft; the complete absence of knowledge of any other style in the world; and, last of all, the immunity from changes of fashion, which enabled the people, from father to son, to go on producing the same designs with practically little variation.

The following firms contributed examples of their manufactures and designs:—

George Bermingham, Leek, Staffordshire.
B. Burnet and Co., King-street, Covent-garden.
Collinson and Lock, Oxford-street.
Debenham and Freebody, Wigmore-street.
Gillow and Co., Oxford-street.
Goodyer and Co., New Bond-street.
Helbronner and Co., Oxford-street.
Lasenby Liberty and Co., Regent-street.
J. Nicholson and Co., Macclesfield.
D. Walters and Sons, Braintree, Essex, and Holborn-viaduct.
B. Warner and Sons, Spitalfields and Newgate-street.
Thos. Wardle, Leek, Staffordshire.

There were also examples of silk brocades and dress stuffs from Glasgow, Halifax, and Patricroft, near Manchester.

The examples comprised plain and satin damasks, brocades with various grounds—some with gold and silver figures—broché and brocatelle, tabourettes or striped silks for furniture, figured silks for court and ordinary dress, figured silks for scarves and ties, and specimens of machine-embroidered silks.

DISCUSSION.

Mr. CUTHBERT QUILTER, M.P., said he represented a part of England where silk-weaving at one time was highly prosperous, but he was sorry to say that the county of Suffolk now possessed only a small number of silk-weavers. Even there, however, he believed the tide had turned, and the silk-weavers of Suffolk, although they did not produce such beautiful fabrics as the specimens exhibited, were occupied much more than they were some time back in producing umbrella and other silk of a useful character. There were one or two points in the excellent paper with which he did not find himself in complete accord, being a free trader, but on that occasion they were not met to discuss political questions, but rather to consider whether any combined effort could be made and maintained for bringing back prosperity to an industry in which this country formerly held such a proud position. What he had heard had opened his eyes considerably, as it showed that there were cases in which we could export our manufactures even to France, the land of taste and elegance, as it was generally called; and of all the beautiful specimens before him, his eyes and thoughts had been principally fixed on those which were made to adorn the walls of the *salon* in the Rue de Rivoli, and in the German Palace. If it could be done in one or two cases, why not in hundreds; he would never believe that an English workman could not do anything which the workman of any foreign country was able to do. Give him a little more education, and that sobriety which he sometimes lacked, his insular hardihood, his strength of purpose, and his determination would carry him to the front in any industry in the world. Artistic education had been sadly lacking, but now every County Council was rivalling its neighbour in providing all sorts of technical instruction, and surely the outcome of that must be some practical good to the nation as a whole. Schools of instruction in design, and schools where could be seen all appliances in connection with weaving, were springing up in the North of England, which he hoped would some day rival the great school at Crefeld, where young men could learn everything con-

nected with their art for a comparatively small sum. He was very thankful, speaking on behalf of a large number of workpeople, whose homes were very dark and dreary, wearily watching the throes of an expiring industry, to hear and see that the silk manufacture of England was not extinct, and as representing the descendants of those who left their homes for conscience sake, bringing their beautiful art to this country, he must say that nothing could be more delightful than to take a share, however humble, in bringing back prosperity to the industry in which their forefathers so excelled.

Lord STANLEY OF ALDERLEY said he had hoped to see many well-known people from Macclesfield and Congleton that evening. He had no right to speak on this subject from an artistic point of view, but he was almost as deeply interested in the material prosperity of Macclesfield as if he lived within the borough. He congratulated the silk industry on this excellent paper, and especially on that portion which stated that before the Cobden treaty there were 57,000 looms existing in five centres, and in the year 1885 they had been reduced to 4,400, because there were gentlemen in Macclesfield who maintained, notwithstanding the deserted aspect of the mills, that the town was flourishing, but when they were asked to produce a balance-sheet to prove it they invariably declined. He was also glad to see the merits of Mr. J. O. Nicholson recognised, for he had done a great deal to promote technical instruction; but when he was able to pass himself off as a Frenchman, he should believe that his fabrics would equal the French in excellence of design, but he did not think that would ever be accomplished in the higher branches of the art. Mr. Nicholson and his friends maintained that the silk industry was perfectly flourishing, but Mr. Ben. Elmy, of Congleton, would say just the reverse. The fact was these people spoke from preconceived notions, and those who were originally free traders stuck to their fetish, and would not allow that anything was wrong. But they should remember that the principle of free trade was that we should not tax anything which we could not produce ourselves, and therefore it was perfectly legitimate on the part of the silk industry to claim that that protection which figures showed were necessary to it should be restored; whilst to avoid anything which would imply feelings of bad neighbourhood to France, they should urge the Chancellor of the Exchequer to follow the lines he had already taken in the budget. He had equalised the duty on French wines to 2s. all round instead of 2s. 6d. on sparkling and 1s. on the common sorts, and if he would put a duty on French silks he would do something to restore the prosperity of the silk industry, and if he reduced the duty all round on French wines to 1s. or 6d., that would balance the loss to France, and give us something to bargain with. The Chancellor of the Exchequer was already coming round to the opinion that in order to secure justice from other countries, and to diminish the present severity of the highest tariffs, we should have something to bargain with, and he had threatened Spain, if it renounced the treaty lately made, that he would re-establish the alcoholic standard against its wines. Some persons thought that a duty on silk would raise the price of silk; but that would not be so, for if our own manufacturers secured the market, internal competition between them would keep the price to consumers down. He could remember that, formerly, in the neighbourhood of Macclesfield, silk pocket handkerchiefs were much more common than they were now. The effect of the Cobden treaty had not been to make commoner silks cheaper than they were. All farmers' wives used to like to have black silk gowns, and there was no reason why they should not be entirely produced in England, as design did not enter into the manufacture, the chief thing being solidity.

Mr. THOMAS WARDLE said he must congratulate the Silk Association on the able advocacy it had received from so great a traveller, and so experienced a textile man as Mr. Purdon Clarke. It was very gratifying and satisfactory to find that the Council of the Society of Arts included silk amongst the subjects to be discussed in the Applied Art Section, and he knew of no body which had done so much for the maintaining the arts and industries of this country, and the functions of that Section had never been discharged in so admirable a manner as of late. We had the misfortune to send every year £11,000,000 of our money to France, Germany, Italy, and Switzerland, for manufactured silks, and this had been going on for twenty-five years, so that no less than £270,000,000 sterling had passed from this country to other countries for doing that which our own artisans could and ought to do. The object of the Silk Association was to endeavour, by all means in its power, to discuss such remedial measures as might at any rate reinstate the silk industry in its former proportions; and having served on two exhibition juries in France—namely, in 1878 and 1889—he did not see any necessity why we should go to any of these continental countries for a single yard of silk. He would not discuss the question of free or fair trade, because, even if he had any pronounced views either way, it would not become him, as President of the Association, to discuss such a subject; nor was it the policy of the Association to allow any fiscal considerations to come in, consisting, as the Association did, probably of an equal number of fair traders and free traders. The question was, could not the Association do very useful work outside any such question. At the Paris Exhibition, in 1889, there was such an exhibition of foreign silk as was never before seen. The Lyons section was absolutely magnificent, and no one would wish to deny it, or would wish to deprive the French of the great consideration they deserved of being manufacturers of silk of great taste, and especially

great knowledge of colour; but notwithstanding that, he came back quite convinced that, in the case of silk for upholstery purposes, in colour, in design, and especially in weaving, our English goods were quite equal, and, in some respects, superior to the French. He need not mention the beautiful silks of Austria, Italy, or Russia, or say anything of Germany and Switzerland, because France stood admittedly at the head of all. With regard to dress silks, France probably would be acknowledged to take the leading part even to-day, but he was not disposed to admit it with regard to fabrics especially adapted for domestic uses, other than those for dress. With regard to the price of manufacturing silks, it was a fallacy, as had been stated, to consider that the English makes were dearer. Very recently he went into one of the principal retail establishments in London, where he was told that English silks could not compete with foreign; and he was much astonished to find, on being shown two samples—one of which he had with him—that it was priced at 28s. per yard retail, 60 inches wide. It seemed an astonishingly low price for silk of that character; and he was also shown, at the same time, a brocatelle from Spitalfields, pretty much about the same substance, the price of which was about £4 a-yard. He felt sure that there was some reason to explain the difference, and asked to be allowed to examine it. He examined both, and found the Spitalfields to be absolutely pure silk, both warp and weft; but when he came to examine the other, he found there was not, strictly speaking, an atom of silk in it. It might be called silk, and was sent into England in great quantity as silk; but it might be useful for ladies to know how easily they might be deceived by prices with regard to such goods. The warp was spun silk, which was known to be manufactured from waste, and of course was much less expensive than that reeled from the cocoon. The weft consisted partly of cotton, but chiefly of Tussore silk, and it was a remarkable example of the utilisation of the wild Indian and Chinese silk. The price, roughly speaking, of thrown Italian silk to-day undyed was about 20s., the price of the raw Tussore in London was 2s. 6d., and the spun silk, of which the warp was composed would be about 8s. or 10s. a pound. He showed the sample to an English manufacturer that morning, and he said that he could easily make silk of the same materials for 15s. a yard. It was very desirable that ladies should be allowed to know what they bought, and the object of the Ladies' National Silk Association was not to ask ladies to wear English silks only, but to ask drapers and distributors to allow them to know what they were buying, and whether they were buying pure silk or weighted silk. If they found the silk was suitable to their wants, and as good as that from France and other countries, they would naturally give a preference to the English. There was no desire to help on the silk industry of this country in a patronising sense, but simply that ladies should be allowed to know what they were buying. Last year the Association received a great shock from one of the leading distributors who, in the *Times* newspaper, said the "English people did not care for English silks because the foreign were better all round." Without going into details to disprove it, which he had fully done at the time, he was quite certain that, with regard to manipulation, colour, and dyeing, many of the silks now shown could not be excelled in any continental country, either in cheapness, durability, or purity of dye. This is particularly so with patterned silks of the lighter and less costly kinds, and also with plain silks, and it is high time that this important fact should be generally known by ladies, who had for years been grossly deceived in this respect by statements to the contrary made by importers of foreign made silks. The interesting and numerous exhibits around the walls fully bore out this. The principal utility and aim of the Silk Association of Great Britain and Ireland probably lay in what it was doing to promote technical instruction. They had in Coventry one of the most useful weaving schools in England, presided over by influential members of the Council; there was another at Macclesfield, and another at Leek, which in its various branches numbered nearly 500 students. Mr. Quilter had been too modest to speak of his own efforts in West Suffolk; being not only member for that division, but a member of the County Council, he had devoted a considerable sum of money to aiding in the development of the industry in Sudbury, Glemsford, Haverham, and other districts, and he had heard lately, from a Sudbury manufacturer, that the trade was looking up, and they hoped before long, with the aid of better technical instruction, to recover their lost ground. In Manchester, the Council of the Silk Association was at work trying to found a central institution for higher technical education in throwing, weaving, dyeing, and finishing, so that the sons of our manufacturers and managers might go there and receive such an education as was given at Crefeld. A journal, entirely devoted to silk, would soon be established, and he had received from the Secretary of H.R.H. the Duchess of Teck a letter, saying he was desired to express her Royal Highness's regret at not being able to be present that evening, and how much she regretted what she feared must be the injury done to the reviving silk industry by the recent national bereavement. He knew no one in England who had taken a deeper interest in the revival of the industry than H.R.H. the Duchess of Teck, and she was very pleased, in view of that recent anticipated event, which then promised to be so happy a one, that the whole of the silk for the royal wedding was to be produced by English looms.

Mr. Lasenby Liberty said it had been most interesting to follow Mr. Wardle with reference to the two examples of silk he had been comparing. He failed, however, to gather whether, in Mr. Wardle's opinion, it would be desirable for the

British manufacturers to adopt the examples set them by their French competitors, that is, to compete with the foreign manufacturer by producing silken fabrics composed of the less expensive materials which Mr. Wardle found in the brocade to which he had called attention. At first he understood Mr. Wardle to say there was no true silk whatever in the French fabric, and, subsequently, that though none of the more expensive yarns were used, the fabric was, as a matter of fact, "all-silk." Mr. Liberty believed the more general introduction of the Tussore silk referred to would secure a two-fold advantage, for besides lending an element of greater durability, it fostered an important industry in which our fellow subjects in India were largely interested. Personally he felt, though it was most necessary to assert our artistic and manufacturing superiority in the Spitalfields and other high-class brocades, it was not desirable to limit the British silk industry exclusively to the more costly goods, as comparatively there could then be but few purchasers, and the trade would be artificially cramped by an altogether unnecessary barrier placed in the path of the expansion and prosperity which could otherwise be attained. He believed the object of the Silk Association should be to secure for the British industry as wide an area of enterprise as possible, provided good and honest materials are used, and an intelligent selection of designs and colours made; and he was strongly in favour of inviting the public to share in every advantage and economy in the manufacture. He might add a recent instance within his own knowledge, in which an English house had been supplying English-made silks to Paris and other Continental centres. They had not extended their operations very far, but the sale was gradually increasing, and it had excited a certain amount of antagonism in Paris, as evidenced by anonymous postcards being received, threatening with dynamite. That unpleasant episode might, he thought, be taken as a compliment to the merits of the English silk manufacture. With regard to the former use of silk handkerchiefs in the neighbourhood of Macclesfield being more general than at present, he had some doubt whether it depended so much on questions of free or fair trade as on a change of fashion, and the now almost total extinction of the habit of snuff-taking.

Mr. BENJAMIN WARNER, speaking as an old Spitalfields silk manufacturer, said he considered the very interesting paper just read would do a large amount of good. He agreed with Mr. Purdon Clarke in saying we should endeavour to increase the practical knowledge we have in this country. In France, the State paid professors to give lectures in the manufacturing districts, and youths went through a thorough course of training in the theory of weaving, fitting them to occupy the position of manufacturers. It had been the fashion of late years to encourage everything foreign, resulting in many of our best men being driven away to enrich other countries. When he was a youth, the Spitalfields silk trade used to provide a living for about 100,000 persons, now it provided a precarious living for only very few. There were thousands in the east end of London who had no regular employment of any kind; the strongest got occasional work at the docks, and their families were assisted by the benevolent, but in his opinion the wisest and best form of charity was to give employment to the people, and unless they were better employed the nation must suffer. At the present time there was a sign of weakness; a few days back he received a paper from the London Chamber of Commerce, asking for replies to questions. The first was—"Did he approve of the £1 note?" to which he replied "Certainly not;" to the second question, "If he did not approve of £1 notes, would he suggest in what way the gold could be kept in the country?" His answer was, "Encourage home productions of every kind." And from an experience of more than fifty years, he knew of no better employment for the working classes than weaving, which, being an indoor employment, was good for both sexes. The delicate treatment which silk required had a refining influence upon those employed, and amongst the weavers, types of men were found of whom any nation might be found. The Silk Association had done some good, more especially the Ladies Committee; they had given the manufacturers substantial encouragement, and he believed that they and Mr. Purdon Clarke would have the satisfaction of knowing that their efforts would bring a blessing to the homes of the working classes.

Mr. J. H. DONALDSON said he was obliged to dissent from some of the views expressed by Mr. Clarke. While he much admired the paper, and felt that it would tend to benefit greatly the class he desired to help, there was nothing to be gained by attempting to conceal from ourselves the fact that there were certain things which the French could do with greater dexterity and skill than we could. There was a sensibility of hand possessed by French workmen by no means common amongst English workmen. Long years of encouragement, the peculiarities of race, natural taste, and, possibly to some extent, the influences of climate, had resulted in producing a workman of great acuteness of mind, of much intelligence—far, he thought, in advance of the average English workman. The French workman had ideas of fashion, taste, elegance, and refinement constantly before him, and, having art all round him, he had brought his natural aptitudes to the development of art in relation to his work, and the result was that you had, for the production of the highest class of silk, a very superior kind of person to the average English workman. In 1889, he went round the Lyons Court of the Paris Exhibition with Mr. Wardle, and well remembered the enthusiasm with which that gentleman spoke of the splendid works there displayed. It must be admitted, even by Mr. Clarke, that nothing

had yet been produced in this country comparable with the best work there shown. They could well understand why that was so; there had been men of the higher class in France who appreciated these beautiful things, and, naturally, where there was the demand, the supply followed. It seemed to him only prudent to recognise these facts; not to attempt the production in this country of the highest class of work, but to adopt rather the suggestion of Mr. Liberty, and produce a medium class of work, thoroughly good of its kind, which could be made use of by persons of comparatively limited means. No doubt, as machinery was perfected, as education advanced, and the people became more intelligent, there would be a nearer approximation to the high-class work produced in France; but you might as well attempt to produce wine in England as an article of commerce, as to produce the very highest class of silk work, such as was produced in France. Why did we pay eleven millions for French silk, and why did America, Russia, and all the great nations elect to go to France for their principal silk supplies, except because the highest class of work was to be found there. Polytechnics, to which Mr. Clarke had alluded rather disparagingly, were doing a very great and valuable work in developing the intelligence of the working-classes. The system of apprenticeship prevailed much more in France than here, it was a thoroughly organised system there; but here the habit of apprenticing boys for five or seven years had nearly disappeared, especially in London. Consequently, there was not that rigid supervision and intelligent direction over the youth which operated so largely in France, and resulted in the production of a splendid and capable workman. They should seek by every means to extend the system of apprenticeship, and induce masters to employ as many boys in their factories as the men would permit, such a system being the best security for the production of efficient workmen.

The CHAIRMAN said, although he believed Lister and Co. to be the largest silk manufacturers in the world, he knew very little of silk manufacture; his *rôle* had been that of an inventor, of technical knowledge he had little. He agreed that if the silk problem was to be mastered, it would be through technical teaching, but though that would do much it would not do everything. It had been neglected in England for many years, and we should have been marvellously more forward if we had thought about it earlier; but somehow or other Englishmen always thought they could beat the world without troubling to learn. Now they were finding out that they would have to learn how to design, to dye, and to do everything else. Still it was a peculiar feature about Manningham that there was not, as far as he knew, a technical taught person about the place. He himself was brought up for a clergyman, and learned Latin and Greek, and nothing else, but somehow he turned to that for which he was naturally fitted—invention. His first efforts were to beat the whole world in wool, and he created in ten years, from 1845 to 1855, the largest wool concern ever seen. He had five establishments in England, three in France, and one in Germany. Having exhausted the field of invention there, he turned to silk; he had no knowledge of it whatever, but he saw there was a field in silk, and set to work by little and little, one thing after another grew, until Manningham became the vast concern it was. Their dyers produced about as fine colours as any in the world, and yet he believed they had not one who had not learned simply by rule of thumb. That only showed that if England could do this without technical education, what might she be expected to do with it. He did not suggest that they were any the better for not being taught; on the contrary, if we could beat other nations as we were, we could beat them vastly better when properly trained. In design, colouring, artistic knowledge, the assimilation of colours, and all that sort of thing, England was behind. Of course there were certain other difficulties, and he might easily be led into delivering a fair trade lecture, especially as he had one prepared to deliver to an audience of 2,000 or 3,000 last week, who would not listen to him, from ill-will caused by the strike; but they were not met to talk about fair trade except in one point of view. He must say there was one thing which made him exceedingly angry. At Manningham, at that moment, they could beat the world, but half of the machinery was covered with dust, and 2,000 workmen were on the street, and that simply because America put on a duty of 100 per cent., in order to exclude English silks; they tried to do it with 75 per cent. and failed, but they managed it with 100 per cent. In Germany, which had a magnificent technical school at Crefeld, they would not allow English untechnical goods to enter. They came here and sold their goods free, but when Englishmen went there, they said, "Oh, no; we are technically instructed here; and we have learned, if you beat us, to shut you out; but when we can beat you, we come over to London, as the best market." That was very provoking; and he could not understand why the English did not learn wisdom. Everyone who had read the history of the silk trade knew that at one time it was very flourishing in England, and they all knew why it did not flourish now. The year 1860 made the finish of it; it never recovered that blow. He concluded by moving a cordial vote of thanks to Mr. Purdon Clarke.

The vote of thanks having been carried unanimously,

Mr. PURDON CLARKE said he would confine himself to replying to what had been said by Mr. Donaldson, because he did not consider that Englishmen should be discouraged in trying to beat the French. We had proved our superiority in many other things, and he was confident, from what he

had seen, that we should be able, if not to beat them, at any rate to rival them in the higher arts. Mr. Donaldson had explained the matter himself, when he spoke of the opportunity France had had. The specimens he had shown that evening were produced by a few manufacturers, working for a very limited market, but France was making for the whole world; and in the fine arts experiment and practice were factors as valuable as that intangible quality known as good taste. France had the advantage not only of that great market, but ideas and demands were sent in from the whole world, and they were all worked up in the Lyons factories. If Spitalfields were placed for a few years in the same position, we should soon level up, and if we had ten years, we would leave France behind. It was perfectly absurd to tell the countrymen of Flaxman, Turner, and Alfred Stevens that refinement in art must be left to the French. He was rather sorry that he had introduced political matters, but that was more the fault of politicians who meddled with questions of commercial expediency which they were either incapable of understanding or did not wish to. He felt very strongly that something should be done to secure a more favourable tariff for the entry of our silks to foreign countries, especially as France was re-adjusting the duties in an adverse manner, and, as Lord Masham had just informed them, the duty on some sorts of silk goods had been raised 100 per cent. in America. Perhaps the solution was to be found in a remark from one of the most important distributors, a Scotchman and a free trader, who said that, whilst he had always been a free trader, and would remain one, he sometimes thought that a little vindictive retaliation might be useful, when other countries imposed prohibitive duties, and that, at the present time, something of the kind was necessary to help our silk manufactures.

Sir George Birdwood writes as follows:—I deeply regret having been forced, by a severe accession of neuralgia, to leave the Society's Lecture-hall before the discussion on Mr. C. Purdon Clarke's paper was half over, and hope that the following remarks which, had I been present, I should have made in reply to Mr. Hunter Donaldson's despairing speech, may not be too late for publication with the official report of the proceedings on the occasion. Confining my defence of the natural artistic aptitudes of our English manufacturers to the proofs afforded within the range of the special manufactures treated of in Mr. C. Purdon Clarke's paper, I will merely say that having been afforded the opportunity, by Messrs. Collinson and Lock, of closely watching for twenty years past the growth and development of the lovely silks and brocades associated with the name of this firm, some of the best known of which were exhibited in the Society's Lecture-hall, I have long been convinced that for stateliness and grace of design, richness and delicacy of colour, and exquisite execution, and general originality of treatment, they are equal to the finest productions of the famous looms of Lyons. I recollect when Messrs. Collinson and Lock first gave up having their silk stuffs manufactured in France. They wanted to reproduce, in large quantity, for the late King of Bavaria, a fine old brocade of the last century, and the price asked by the Lyons weavers was so enormous that they resolved to have the work done at home, and, after many abortive trials, with the successful result seen in the beautiful brocade shown by them under the name of "Malta," and sold by Messrs. Collinson and Lock at about half the price a Lyons silk manufacturer would charge for it. This was in "the seventies," and since then this pattern has been produced in every combination of colours, and hung in many historic houses, including the Imperial castle of Charlottenburg. Next, they brought out a number of pure silk damasks, dyed by Mr. Thomas Wardle, and sold them at the price of fairly good "tapestry." They are dreams of exquisite colouring, but substantial as "cloth of gold, of tissue." More recently, they have been systematically reproducing the noblest designs of the Renaissance period to be found in textile fabrics, and in novel combinations never before attempted—gold brocades, and silver and gold brocades, and brocades of mixed threads of gold and silver and silks, and with effects of colour worked out entirely by Mr. George J. S. Lock, and peculiar to himself. They were hanging on the Society's walls last Tuesday; but it is at the Lyceum Theatre, in Mr. Henry Irving's mounting of *Henry the Eighth*, that they are to be seen in all their splendour and glory; and as I have referred to Mr. Henry Irving, let me add that no one has done more than he to promote the revival in our generation of the noble silk industry of England, so true is it that, as Cicero has said, all the arts are connected together:—"Omnes artes, quæ ad humanitatem pertinent, inter se continentur." Mr. Hunter Donaldson must have seen these things; and seeing them, should surely have perceived from them that in this country we have the means of accomplishing anything and everything that could be attempted in the way of artistic silk weaving, provided only the resources at our command are directed by knowledge, taste, and the high courage that can peremptorily and resolutely "damn the expense."

Miscellaneous.

IRRIGATION OF ORANGE GROVES IN JAFFA.

The United States Consul at Jerusalem says that the orange groves, and their system of irrigation, though they have been greatly extended within comparatively recent times, have unquestionably an origin of great antiquity. The area of land unde

irrigation at Jaffa would exactly include the space occupied by its orange groves, being nearly one-third of the cultivatable ground belonging to the community—that is, of 9,000 acres of cultivatable land, about 3,000 are under irrigation. The orange and the lemon are the chief crops; but other fruits, such as citrons, limes, peaches, apricots, grapes, pomegranates, and melons, and all the ordinary garden vegetables, are also produced in abundance, and of fine quality. The vine especially is of late receiving much attention, and within the last few years extensive vineyards have been planted. Neither the vine nor the olive, of the latter of which there are many groves, requires any water other than the usual rainfall. The superiority of the Jaffa orange is world-renowned, whether its size or flavour is considered. In an average season, oranges and lemons, together with other fruits and vegetables, to the value of £67,000, have been exported from Jaffa, and in addition to these there is an immense home consumption. The sources of the water-supply are wells, which are fed by underground springs. The engine in use for raising the water is, in every case, without exception, the so-called *bajara* or *bayara*, a wooden machine of the most simple construction, driven by horse or mule. Its principal parts are a whim beam or capstan, with horizontal wheel attached, moving a vertical wheel connected by shaft with a third wheel, which carries a chain holding reversible buckets. A pole inserted in the whim beam is fastened to the horse or mule, and the whole machinery is set in motion, the wheel with buckets revolving in the well, dipping up the water and emptying it into the conduit or tank. The tanks are usually close to the wells, and are cemented basins built of stone. They are filled during the day, the water being distributed from them through the various channels during the night, in order that the loss by evaporation may be reduced to a minimum. There are about 700 of these *bajaras* at work in Jaffa, and the system of water distribution, being entirely under private control, is governed by neither law nor regulation. The quantity of water used per acre during the season of twenty-three weeks is 2,300 cubic metres, at a cost of 10d. to 1s. per diem. Thus, for instance, the average expense of irrigating an orange garden with an area of five acres, would be about £38, and the value of the crop may be estimated at from £100 to £150. As to the antiquity of the system of irrigation, the close resemblance of the *bajara* to the Spanish *noria*, has induced many persons to imagine that it was introduced into Jaffa at some early period from Spain, but as the family likeness of these wheels to the ancient Persian wooden water-wheel is equally great, and as the orange tree was found in Palestine by the Crusaders, in the 11th century, the actual system of irrigation, says the United States Consul, might well belong originally to Palestine, or may have been introduced from Persia. Owing to the peculiarity of the climate, the orange groves are obliged to be watered during the summer months, or, rather, during the dry season, when no rain falls, that is from May till October, or November. The rainfall in the winter months, that is, from November to May, varies from 17 to 30 inches. The phenomenon of the "air cushion" is seen in Jaffa, says Consul Gillman, to perfection. Before a rain sets in, it generally takes several days of preparation before the result appears. Great clouds roll up and cover the heavens with their dense masses, but they attempt in vain to discharge their contents, or, if they do succeed in dissolving, the thirsty atmosphere drinks up the moisture before it even reaches the earth. And this must continue till the intervening strata composing the "air cushion" are sufficiently saturated to permit the rain to fall through, which then occurs in a violent and often injurious downpour.

METEOROLOGICAL CHANGES IN FRANCE.

Mons. Flammarion, the French astronomer, has recently been directing attention to the climatic changes in France. According to the United States Consul at Bordeaux, he states that, from actual figures obtained within the past six years, the temperature of Europe has been falling. France has been suffering for a long time from an excess of cold weather, the thermometrical readings at Paris having been one degree Centigrade below the normal height. Other readings show even less favourable results. The fall is more noticeable in the spring than during other periods of the year. Similar phenomena are recorded in Great Britain, Belgium, Spain, Italy, Austria, and Germany, while the really cold countries, such as Denmark, Norway, Sweden, and Russia, have enjoyed, during the last four years, a temperature slightly above the average. In the days of Philippe Auguste, in the 13th century, the wines of Etampes and Beauvais, were the favourite beverages at court. Henry IV., a pronounced *bon vivant*, frequently expressed his fondness for the product of the Suresnes grape. At the present day, there is not a vineyard of importance north of Paris; and as for the *petit vin* now made at Suresnes, it has become only the drink of the poorer classes. In the middle of the 16th century, Macon was celebrated for its muscat wines, whereas the muscatel grape, at this moment, can scarcely be made to thrive there. Ancient chronicles mention the cultivation of the vine in Northern Brittany, where now even apples are not plentiful. Again, it is to be remarked that trees which once flourished in the north of France, are at present found only in the extreme south, and a considerable number have disappeared altogether. Languedoc no longer grows the lemon; there is not an orange left in Roussillon. The Lombardy poplar, so familiar and picturesque an object in old French line engravings, is now nowhere to be found on French

soil. These are facts which, says Consul Knowles, putting statistics out of the question, serve to illustrate the changes wrought by temperature in the great fruit-producing country of France.

Correspondence.

THE OPIUM QUESTION.

Having been employed for about twenty-five years in the Province of Guzerat, in which the habit of opium eating is notoriously prevalent, I can state from personal experience that, so far from that habit being injurious to the well-being of the people, morally as well as physically, the peasantry of the province, and especially those of Kaira, are the finest, most industrious, most skilful in agriculture, and the most law-abiding that we have in Western India. There can be no doubt that if by any means the habit could be put a stop to, the people would be forced to resort to some other stimulant or narcotic to counteract the malarious effects of the climate. The alternative would be either the frightful produce of hemp, in the shape of *bhang* or *hashish*, under the influence of which, it may be noted for the information of the anti-opium agitators, the crime of running "a-muck" is invariably committed, or the drinking of the fermented juice of the palm. I should like to draw attention to the comparative results of opium eating and intoxication from this spirit, as shown by criminal statistics. Taking the whole population of Kaira—notorious for opium eating —and that of Tauna (Phána), where the palm abounds, for the year 1890, the last year for which statistics are available, I find that, whereas in the former one in 334 was charged with crime of some sort, in the latter, one in 159, or, say double the number, was so charged. These statistics are amply borne out by my experience as Police Commissioner in both these districts. I can, in fact, only recollect one single instance in which I saw a man at all the worse for eating opium. This was in the case of a Rajpoot official, who appeared half-dazed, and unable to answer questions intelligently. He, however, left my tent for a minute, and came back, after taking his little dose, which acted as a pick-me-up, as brisk and intelligent as anyone could wish to see.

Mr. Batten, in his paper, talks of the difficulty attending the establishment of a frontier line of 2,000 or 3,000 miles. This probably refers only to the old preventive salt line, as that length of line would probably not suffice for Guzerat alone, in which British and Gaekwari villages are greatly intermixed, especially in those parts of the country in which the poppy is most successfully cultivated. Where such is the case, it would be simply impossible to put a stop to the smuggling of an article like opium, of which a quantity sufficient to last a moderate eater for a year, at the rate of 10 grains a day, can be easily carried in one's pocket. The anti-opium party are strong on the point of putting a stop to the growth of the poppy. They are probably not aware that such has been the policy in Bombay, ever since we took possession of the greater part of the country rather more than 70 years ago. This has, however, not had the effect of putting a stop to the practice of opium eating, as they imagine it would. The Indian Government have been wise enough not to attempt the insane task of "expelling nature with a pitchfork," and have supplied good opium for consumption through licensed vendors, and have thus, I have no hesitation in saying, saved the people from decimation. If you cannot by law prevent the use of opium, or some kind of intoxicating stimulant, in India, does it not stand to reason that the better policy is that of controlling it as far as practicable? You cannot put a stop to the drinking of beer and spirits in England; would any Government sufficiently insane to do away with the licensing of public houses and abolish the tax on drink remain long in power?

But the greatest argument in favour of the continuation of the present system in India lies, as I have already stated in a letter to the *Times*, published about two months ago, in the impossibility of preventing the growth of the poppy in the native States everywhere intermixed with British territory. Were England to double her national debt, with a view to compensating those States for the abolition of its legal cultivation, I maintain that with the whole people in opposition to us, we could no more carry out the policy than the Government of China are now able to do. Under all these circumstances, were it not for the evident illusions, arising from the deaf-adder like proceedings of the Anti-Opium Society, and the mistaken sincerity of some of its members, the arguments they bring forward against the opium system in India may be designated by no worse than the appellation of childish. If they are in want of a reasonable policy, let them agitate for the adoption of the British system in all native States by the rulers of those States. Treaties to this effect were entered into with those in Guzerat on the assumption of British rule there, and might probably be carried out without much difficulty elsewhere.

A. Rogers,
Late Revenue and Police Commissioner in Guzerat.

ENGLISH TRADE AND COMPETITION.

My friend, Mr. Ewing Matheson, has dealt with the subjects of exchange and trade, which are of particular interest to the Society of Arts. As Mr. J. Biddulph Martin and himself say, it is not easy always to get at the exact facts of matters so complicated. It is true the Germans have long carried on a fierce competition, but whether they have so fully

succeeded, and whether the English are such fools as writers on the subject suppose, Mr. Matheson is inclined to doubt.

Mr. Matheson knows that he is stating what is correct, when he says (p. 508) that it is not all profit to the German. There are countries where there is no English or American merchant, and where the Germans have stepped in. On a little inquiry, we should find that there are big houses here which have no longer any trade in the country, but which have, after twenty or thirty years, large sugar and coffee estates belonging to them, and hanging on their hands. One curious thing is that some of these merchants are of German birth, because the great houses in London include Hamburghers and other Germans, who have preferred an English habitat for carrying on their foreign business, and these are among the parties incriminated as being inferior in enterprise to the Germans.

A young German clerk sets up as a shopkeeper in a country, and he readily receives support from Germany in the supply of goods, and in obtaining credits. He carries on a direct trade with the storekeepers and planters, and does a very good business, and goes ahead. By-and-bye comes the coffee-borer, a civil war, or some other plague, and the whole trade is stopped. His German friends are locked up, but they are "secured"—secured with a vengeance by coffee estates. Of this process in time they get sick. The London houses know it, and it is not want of enterprise keeps them out of the market.

Another chance for the young German is this. In the corrupt states of South America the goods are smuggled by connivance of the local houses and the Customs directors. This is business which the English and American houses will not do, and, of course, they cannot compete with local houses. A few years ago there was not an English or American house left in Mexico on this account.

The young German clerk goes in for contraband, and does well. Some day an opposition political party will get into power, and put the Customs directors and merchants in jail, and take measures to extract as much of the spoil as they can.

The German shopkeepers all over the world do a large business in bogus English and French goods at low prices, with forged trade marks, and which are sold to native shopkeepers in fraud.

A large resource to the German dealers is to obtain goods from German manufacturers, who get no returns, and are plundered to an enormous extent. As Mr. Matheson intimates, the English manufacturer does not show a readiness for this kind of business nor the requisite enterprise. He therefore prefers (p. 508) to leave to merchants here to look after the money to be paid for his goods, instead of losing.

This explains the late Foreign-office correspondence, where a London house declined to supply goods to a Bulgarian house in Sofia, except for cash in London. On any other conditions they had no remedy for their money. H.M.'s Consul need not have been much surprised at this result. Another house refused to supply a less consignment than 150 tons of slates, to the great surprise of that functionary.

A large branch of German and Belgian enterprise, with which Mr. Matheson is acquainted, and which is not so profitable as it assumed, is the sale of metal, engineering and other goods in this market, at lower rates than the local prices, for the purpose of getting money to work the foreign factories.

The Lyons silk manufacturers also do something in this way. As they cannot sell locally under the trade "scale," when they want money they send to this market, which is the slaughter-house of the world, and raise money here. The statistician has some interesting figures of so many goods and so much value, but which do not represent the real nature of the transaction, which is a loss for France. Some of the goods are sent abroad, so as to compete at under prices with French silks. Board of Trade figures do not always represent commercial facts.

Where the business is carried on by mercantile credits, English commercial travellers do not go, because all goods are purchased by the English house, and this gives one of the commissions on the business.

Scattered over the world is a large body of French traders, who deal in articles de Paris, French silks, &c., and for which they receive ready-money, transmitting it with the orders to the relative or correspondent in France, sometimes in advance. No French traveller stands a chance there. In some places specie is remitted in groups, in some bills of exchange, and a large amount of the imports of specie by steamers is on French account. They sell genuine articles and get their own prices. The Catalan shopkeepers are again doing a large business of the same kind, and so are the Genoese and other Italians.

The smaller houses rarely deal in produce for export, though in the present day the numerous steamers that call give facilities. Produce goes mostly to the English houses, unless it is a special article for the French, American, or German market. In many cases the produce goes in the nature of things to the English houses, as they make advances on crops, and the produce may be shipped to Havre, Hamburg, Bremen, Rotterdam, or some other port.

The produce houses generally have in their hands the bill market and the sale of bills, regulating the rate among themselves, including all the English and foreign houses. A well-established house makes a separate profit on the drafts that are sold, and sundry commissions.

One little matter that is known in connection with certain places is liquidation. The local houses periodically wind up, leaving the foreign creditors minus. Calcutta, Constantinople, and Smyrna, have carried on the business of liquidation for above a century.

Wherever there is a Consular Court, and there are plenty of these now, the English merchant has no

remedy against his local debtor, who is under the protection of some consulate, and his consul stands by him against the foreign claimant.

In many other places there is no remedy if the judge is godfather or *compadre* with the defendant.

These are a few cases in support of Mr. Martin and Mr. Matheson that the incidents of trade are rather more complicated than appears on the surface, and not wholly dependent on commercial travellers or price lists. It is not the business of merchants to state their course of trade for the amusement and instruction of writers in newspapers.

Of late there has been an enormous expansion of trade in the world, and many countries are getting a share of this, but we cannot relax our exertions.

HYDE CLARKE.

CHICAGO EXHIBITION.

Mr. G. N. HOOPER writes:—The American people invite all the world to a great festival *and competition* at Chicago. They do so not as philanthropists, but champions in a struggle for supremacy in manufactures and commerce. As evidence that they are in earnest, and that this effort is no child's play, they incur a vast expenditure, they plan and build vast and handsome structures, not for use only, but to please the taste. There are to be amusements and pleasures as well as serious business, and still more serious adjudication of rewards.

The stakes are heavy, but the gains and losses may be proportionately heavy. But, to make the gains certain, and the losses unlikely, they have sent an able Commissioner to repeat the general invitation, and to make it almost personal.

The collection of foreign exhibits is undertaken under immense difficulties, with an almost (and intentionally) prohibitive tariff. That tariff is not of exceptional advantage to the United States, for under it the rivalry of American shipping has been removed, while that of our country has been immensely extended.

In these days, isolated individual exhibitors, in many cases, are at a great disadvantage, for without previous arrangement with others, they may chance to exhibit large quantities of similar goods, create needless and reckless competition and profitless trade, while other goods are not shown, and trade is thereby lost. By a carefully selected exhibit of the *best goods* of the *best makers*, a good impression can be made on visitors, and advantages directly come to those whose goods are not shown, as well as to the exhibitors themselves.

The Institute of British Carriage Manufacturers is endeavouring to arrange for a very select exhibit of twelve carriages of the best London, provincial, Scotch, and Irish makers, each to show some special carriage for which they have a reputation. Such an arrangement has been worked by French and Belgian makers, and if our very free institutions permit such joint action for mutual support and advantage, it appears to me to be the best for such occasions, where heavy expenditure and disappointment are frequently the lot of those who act without looking closely to ascertain the best ways and means to accomplish the end they desire to attain. Our ancestors shed their blood freely, and spent millions of treasure to extend British influence and trade.

Times have changed—and we are now invited to a peaceful and commercial struggle, where time and money have to be spent to hold our own; but these sacrifices are trifles when compared with those of our ancestors, who did the fighting years ago, and formed the commerce that our generation now enjoys.

Notes on Books.

A FIRST BOOK OF ELECTRICITY AND MAGNETISM: for the use of Elementary Science and Art and Engineering Students, and general readers. By W. Perren Maycock, M.Inst.E.E. London: Whitaker and Co.

This work is intended as an introduction to the ordinary text-books of the subject, and covers the syllabus of the elementary stage of the Science and Art Department. The first part is devoted to magnetism, the second to electrokinetics or electricity in motion, and the third part to electrostatics or electricity at rest. Questions are attached to each part, and a list of apparatus required is added at the end of the book.

THE PRACTICAL TELEPHONE HANDBOOK AND GUIDE TO THE TELEPHONIC EXCHANGE. By Joseph Poole. London: Whitaker and Co.

In a volume of convenient size Mr. Poole has succeeded in giving a large amount of information respecting the telephone and its latest developments. The various instruments in use are fully illustrated, as well as the necessary apparatus. The special Exchange systems are also explained. The book has on the whole 227 cuts.

ENCYCLOPEDIE SCIENTIFIQUE DES AIDE-MEMOIRE. Edited by M. H. Leauté, Membre de l'Institut. Paris: Gauthier-Villars et fils.

Résistance des matériaux, 1892. By M. Duquesnay.

Distribution de l'électricité par installation isolées, 1892. By R. V. Picou.

Transmission de la force motrice par air comprimé ou raréfié, 1892. By Al. Gouilly.

Etude expérimentale calorimétrique de la machine à vapeur, 1892. By Professor Dwelshauvers-Dery.

The above four volumes all form part of the technical series, published for the use of engineers

and contractors under the title of the *Encyclopédie Scientifique des Aide-Mémoire.* Each book contains a collection of formulæ, tables, and other information relating to its own subject. That of M. Duquesnay has a bibliography of French books and memoirs on the subject of the strength of materials, strains, &c. All the treatises appear to be of a thoroughly practical character.

HANDBOOK OF THE UNITED STATES. Edited by Moses King. London: Osgood, McIlvaine, and Co.

A very full and complete guide-book to the States. Each State has a separate section to itself, giving its history, statistics, description, accounts of the principal cities, &c. These are all arranged alphabetically. There is a map of each State, and the book is very fully illustrated throughout, there being 51 coloured maps and 2,600 illustrations.

THE ADVANCED CLASS-BOOK OF MODERN GEOGRAPHY: PHYSICAL—POLITICAL—COMMERCIAL. By William Hughes and J. Francon Williams. London: George Philip and Son.

This volume contains a full account of the various countries of the world, in which particular attention is paid to the industries and trade of the countries, as well as to the physical properties and political condition. The introduction deals with the essential elements of the science of geography, and contains an account of the geographical distribution of man, and of the necessaries of life.

PYE'S SURGICAL HANDICRAFT: A Manual of Surgical Manipulations, Minor Surgery, and other matters connected with the work of House Surgeons and Surgical Dressers. Third edition, revised and edited by T. H. R. Crowle, F.R.C.S. Bristol: John Wright and Co.

The author states that his aim in producing this book has been to draw special attention to the manipulative side of surgery, and to impress upon students that, although surgery is becoming more scientific day by day, yet that surgeons can never cease to be handicraftsmen. The subject-matter of the book is treated under 10 sections—(1) On the arrest of hæmorrhage; (2) apparatus for restraint and support (bandages, splints, &c.); (3) of fractures; (4) wounds, ulcers, burns, &c.; (5) cases requiring prolonged or mechanical treatment; (6) emergencies, such as drowning, poisoning, &c.; (7) anæsthetics; (8) extraction of teeth and management of aural cases; (9) minor surgery; (10) preparation of patients for operation, &c.

Three chapters are contributed by other writers: that on the administration of anæsthetics by Joseph Mills; that on the extraction of teeth by H. Howard Hayward; and that on the practical management of aural cases by G. P. Field. The book is fully illustrated.

EPITOME OF MENTAL DISEASES: with the present Methods of the Certification of the Insane, and the Existing Regulations as to "Single Patients," for Practitioners and Students. By James Shaw, M.D. Bristol: John Wright and Co.

The title of this book sufficiently explains its contents; but, it may be remarked, that one chapter is devoted to an index of symptoms with the mental diseases in which they occur, and that another contains an index of mental diseases, with their synonyms and symptoms. The last chapter is devoted to the consideration of legal regulations and forensic psychiatry, and contains forms of certificates, orders, &c., now in use, and a statement of the legal tests of insanity, and legal responsibility of the insane.

SOLUTIONS. By W. Ostwald, translated by M.M. Pattison Muir. London: Longmans, Green, and Co.

The translator points out that a complete account of the facts relating to solutions, and the theory drawn therefrom, is only to be found in Professor Ostwald's "Lehrbuch der Allgemeinen Chemie," and he has therefore translated the portion of that book which relates to the subject, and published it as a substantive work. The author has revised the translation and made such changes and improvements as he considered necessary. The subjects of the various chapters are as follows:—Solutions in gases, solutions of gases in liquids, solutions of liquids in liquids, solution of solids in liquids, osmose, diffusion, vapour pressures of solutions, freezing points of solutions, salt solutions, and the simultaneous action of several solvents.

EXERCISES FOR TECHNICAL INSTRUCTION IN WOOD-WORKING: designed and drawn by H. Jay; arranged by E. R. Kidson. London: Longmans, Green, and Co.

These illustrations of the art of wood-working are shown on eighty-seven cuts divided into three sets, each set being contained in a cloth case. The different processes in carpentry and joinery are clearly shown, and short explanations are also given on the cards.

General Notes.

CHICAGO EXHIBITION.—The French Chamber of Deputies have just voted £130,000 as a grant for the proper representation of France at the Chicago Exhibition.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

APRIL 27.—Prof. ROBERT WALLACE, "Egyptian Agriculture." Lieut.-General MICHAEL, C.S.I., will preside.

MAY 4.—J. N. SHOOLBRED, B.A., "The Bradford Corporation Electricity Supply."

Papers, the dates of reading of which are not yet fixed :—

"The Fisheries Department: its Position and Prospects." By J. W. WILLIS BUND.

"Colour Blindness." By Captain W. de W. ABNEY, C.B., F.R.S.

"Uses and Applications of Aluminium." By G. L. ADDENBROOKE.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

APRIL 28.—Sir WILLIAM WEDDERBURN, Bart., "Reorganisation of Agricultural Credit in India." SAMUEL SMITH, M.P., will preside.

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

APRIL 26.—Sir EDWARD BRADDON, K.C.M.G., "Australasia: its Progress and Resources." Sir ROBERT G. W. HERBERT, K.C.B., will preside.

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MAY 17.—WILLIAM SIMPSON, R.I., "Mud as a Material for Architecture in India and the East."

Mr. Robinson is unable to read the paper already announced for this evening on account of ill-health, and Mr. Simpson has kindly agreed to take his place.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

DR. PERCY FRANKLAND, F.C.S., "Recent Contributions to the Chemistry and Bacteriology of the Fermentation Industries." Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 25 ....Chemical Industry (London Section), Burlington-house, W., 8 p.m.

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. E. G. Wheler, "Leases to Limited Liability Companies."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Sir Edward Braddon, "Australia: its Progress and Resources."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. James Swinburne, "Electric Light Measuring Instruments." 9½ p.m. Reception by the President and Council.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. R. Henry Rew, "An Inquiry into the Statistics of the Production and Consumption of Milk and Milk Products in Great Britain."

Photographic, Great Russell-street, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Professor R. K. Douglas, "The Social and Religious Ideas of the Chinese, as illustrated in the Ideographic Characters of the Language." 2. Mr. Joseph Offord, jun., "The Mythology and Psychology of the Ancient Egyptians."

WEDNESDAY, APRIL 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Robert Wallace, "Egyptian Agriculture."

Geological, Burlington-house, W., 8 p.m. 1. Mr. Ernest A. Floyer, "Notes on the Geology of the Northern Etbai, or Eastern Desert of Egypt; with an Account of the Emerald Mines." 2. Mr. Alex. Carson, "The Rise and Fall of Lake Tanganyika."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Dr. E. Giltay, "On the use of the Camera Lucida in drawing Bacteria." 2. Mr. F. Chapman, "Foraminifera of the Gault of Folkestone." 3. Surgeon P. W. Basset-Smith, "On some Deep-Sea Deposits collected during a Voyage of Her Majesty's ship *Penguin*, 1891." 4. Mr. W. M. Osmond, "Simple Photomicrographic Apparatus."

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. (Annual Meeting.)

Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Second Spring Exhibition of Flowers.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual General Meeting.

THURSDAY, APRIL 28.. SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir William Wedderburn, "Reorganisation of Agricultural Credit in India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Electrical Engineers, 25 Great George-street, S.W., 8 p.m. Mr. A. P. Trotter, "Notes on the Light of the Electric Arc."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,058. Vol. XL.

FRIDAY, APRIL 29, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 27th inst. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Professor James Dewar, M.A., F.R.S., James Dredge, C. Malcolm Kennedy, C.B., W. H. Preece, F.R.S., Sir Owen Roberts, M.A., F.S.A., with Sir Henry Trueman Wood, M.A., as Secretary.

APPLICATION FOR SPACE IN THE BRITISH SECTION.

The Royal Commission are now able to announce that, her Majesty's Government having increased the grant placed at their disposal for the purposes of the British Section, from £25,000 to £60,000, they can dispense with any charges for space at the Exhibition, and will return to the intending exhibitors the amounts already paid on that account.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 27, 1892; Lieut.-General J. MICHAEL, C.S.I., in the chair.

The following candidates were proposed for election as members of the Society:—

Collins, Ernest, The Gables, Wedderburn-road, Hampstead, N.W.
Deverell, Frederick Harold, The Custom-house, E.C.
Dowling, Dennis John, Bromley, Kent.
Elworthy, Herbert S., care of William Watson and Co., Bombay, India.
Fowler, Alexander Farquharson, Highfield, Ashton, Preston, Lancashire.
Gray, Robert, Glenclune, Port Glasgow.
Grinlinton, J. J., care of Darley and Butler, Billiter-square-buildings, E.C., and Colombo, Ceylon.
Grover, Colonel George Edward, R.E., British Section, World's Columbian Exposition, Chicago, U.S.A., and United Service Club, S.W.
Gwynne-Griffith, J. St. A. Mansel, Hendre-Owen, Bedford-park, Chiswick.
Hutchinson, Surg.-General Robert F., 35, Clanricarde-gardens, W.
Ismay, Thomas Henry, J.P., D.L., Dawpool, Birkenhead.
Jones, Julius Marris Wilson, 309, Kennington-road, S.E.
Kempster, William Henry, M.D., Oak-house, Battersea, S.W.
Osborne, Major-Gen. W., United Service Club, S.W.
Rollit, Sir Albert Kaye, M.P., LL.D., Dunster-house, Mark-lane, E.C., and Cottingham, East Yorks.
Sanbergue, Arthur de, 3, Victoria-street, S.W., and Barbadoes, West Indies.
Sandell, Henry William Adrian, M.R.C.S., L.R.C.P., Leighton Buzzard, Bedfordshire.
Sherwell, John William, Saddlers'-hall, 141, Cheapside, E.C.
Tonks, J. William, Victoria-street, Birmingham.

The following candidates were balloted for and duly elected members of the Society:—

Adams, Edgar T., The Cottage, Halstead, Essex.
Archer, Edgar, Ingleside, South Norwood-park, S.E.
Bean, Alexander Thomas, 7, Victoria-street, S.W.
Curtis, Alfred Harper, B.A., 13, South-hill Park-gardens, Hampstead, N.W.
Foster, William, M.A., Chemical Laboratory, Middlesex Hospital, Mortimer-street, W.
Gott, B. S., M.A., Corinium, St. Mark's, Cheltenham.
Hills-Johnes, Lieut.-General Sir James, K.C.B., V.C., Dolancothy, Llandilo, South Wales.
Pitt-Rivers, Lieut.-General A., Rushmore, Salisbury.
Staley, Thomas Peace, 2, Fenchurch-avenue, E.C.

The CHAIRMAN apologised for the absence of Professor Wallace, whose sudden indisposition entirely prevented him from travelling from Edinburgh.

The paper read was—

EGYPTIAN AGRICULTURE.

By Professor Robert Wallace.

Introduction.

By the land of Egypt is usually meant the broad fan-like expanse of the Nile delta and the narrow valley of alluvial land on the banks of the river as far south as Wady-Halfa, hemmed in on each side by rocky walls which have been left as the wearing action of the river in past ages formed the valley through the desert plains of North Eastern Africa. The whole country is completely dependent upon the supply of Nile water for its fertility. Eight inches is the mean annual rainfall at Alexandria, and in the neighbourhood of the Mediterranean coast during the winter season, and there is a rainfall throughout the delta, though in diminished quantities, in the direction of the south; still the climate is such that crops could not be grown without an artificial supply of water.

Basin Irrigation.

In the olden times, the method of applying water was extremely simple. Great earth walls near the banks kept the river within bounds at high flood, and the fertile areas were divided into large basins by earth-banks running across the country at convenient distances. Red water from the Nile was let into these basins, and allowed to stand to a depth of three feet or more, from about forty to sixty days, until the whole earth had become thoroughly saturated, until the weeds had been drowned or had died in the darkness produced by the muddy water, and until the fertilising layer of finely-divided red mud, brought down from the Abyssinian mountains, had been deposited to be left as an oozy warping. After the imprisoned water was allowed to escape into the falling or shrinking river, the seed was sown on the soft mud as the water receded. At times the land was left until it was dry enough to be ploughed, then it was thoroughly broken up and the seed sown on a well-cultivated but moist seed-bed. Sufficient moisture for the supply of the crop was retained under both circumstances, but where the soil was not ploughed after watering, the surface became very hard, and tended to crack and to injure the roots of the plants as they grew. This system of irrigation has almost disappeared from the delta or Lower Egypt, but it is still to be seen in Upper Egypt where, till this day, only one crop is gathered annually from a large proportion of the cultivated land.

Canal Irrigation.

Lower Egypt and a portion of Upper Egypt are under the canal system of irrigation, first introduced by Mohamed Ali, and now being rapidly developed and improved by the British engineers who were brought from the Indian Irrigation Department in 1882.

Modern Egyptian history may be said to date from the beginning of the time of Mohamed Ali, the founder of the present dynasty. All great improvements are in the native mind traced back to his time, and if the attempt be made to learn from tradition what existed in Egypt before him, the inquirer is met by the familiar native query, "Who knows?"

The difference in the power of the two systems to maintain soil-fertility may be gathered from the fact that a good crop of wheat grown under the basin system of Upper Egypt yields 5 ardebs (5·44 bushels each) or about 27 bushels per acre; while, unless specially manured, the yield runs down under canal irrigation to three and a half ardebs. In the latter instance the greater number of crops taken, and the reduced amount of Nile-mud deposited, make artificial manures necessary. A combination of the two systems gives by far the best results, as by judicious management the advantages of both can be secured.

Sabakh as Manure.

A wonderful store of natural manure, called "sabakh," has for a number of years been drawn upon by cultivators in the shape of refuse earth from the mounds of ancient villages and from the floors and surroundings of the mud huts of the present generation. The soil near human dwellings, of a primitive kind, naturally becomes incorporated with the solid and liquid excreta of the residents. In a climate like Egypt this is not nearly so much washed away by rain as would be the case in this country. It is therefore not to be wondered at that, after many generations have lived and died, large accumulations of valuable manure should exist, and that the cultivators should find out the value of it, and carry it long distances to their impoverished fields. Lines of camels and active little donkeys may regularly be seen streaming out of Cairo laden with the rich powdery earth riddled out of the immense rubbish piles of old Cairo.

The sabakh heaps must, within a few years, become exhausted, and artificial manures will

then be necessary to keep up soil fertility to its original very high standard under basin irrigation.

It is true that other means besides the direct application of manure can be resorted to in order to maintain the high degree of fertility. (*a*) Land under irrigation may be, from time to time, warped by muddy water as in basin irrigation; (*b*) the rotation of crops can be elaborated and improved by introducing "barsîm," or Egyptian clover, *Trifolium Alexandrinum*, which, like the bean and other leguminous plants, leaves the lands rich in fresh decaying vegetable remains containing organic nitrogen; and (*c*) greater numbers of live-stock, especially sheep, may be kept on the extended area of barsîm to increase the production of animal manure.

Surface Features of the Country.

The Nile delta is covered with an immense network of irrigation canals, mainly fed by three great arterial canals, which leave the river near the great Barrage, which stands a few miles to the north of Cairo, at the bifurcation of the Nile, where it divides into the only two remaining self-acting outlets which communicate directly with the sea, by name the Rosetta, or western branch, and the Damietta, or eastern branch.

The surface of the land, though unbroken by hills or rocks, and only here and there by palm groves or single standard trees, is by no means a uniformly level plain. It is ribbed by land lying along the banks of all the main waterways a few feet higher than the general level, owing to the tendency of sluggish flowing muddy streams to raise their banks for a considerable distance inland, and even their beds, above the level of the surrounding country.

The Damietta branch has this tendency more fully developed than the Rosetta branch. The latter scours its channel, whereas the former is sluggish, and liable to silt.

The banks, which are artificially raised along the sides of the rivers and canals generally to keep the high flood waters within control, have, in the case of the Damietta branch, to be exceptionally perfect; and even then they are a source of anxiety to the irrigation department, as the water at high Nile stands considerably above the level of the cultivated land outside its banks, and is liable to be flooded or drowned out in the event of the bank breaking—a misfortune which has repeatedly occurred in the past. It is found necessary to resort to the *corvée*, or forced labour, for the maintenance of the Nile banks. Happily, this degrading system is abolished in all but exceptional circumstances in which the interests of the community are involved. Watching the banks and repairing breaches in flood-time are necessary exceptions, but mending banks when there is no urgency is now—since, and including, 1890—done by contract, at Government expense. A broken river bank in Upper Egypt is not looked upon with alarm, as the land near the river in that division of country is above high Nile. The division banks of the basins are supported by the water they contain, and are not liable to suffer unless in windy weather, when waves are raised to wear away the tops of the banks if not properly bound with the roots of strong grasses or reeds.

River-training.

River-training is one of the practices in the irrigation department, introduced by the British engineers in Lower Egypt. It now costs £20,000 a year to make spurs to direct the river for the purpose of preventing erosion of its banks, and to save the land from being worn down and carried away. In Upper Egypt this work is confined to the saving of a mosque or some relic of antiquity.

In the olden times no effort was made to guide the course of the stream; if the natural bank of the river began to wear seriously, the protecting bank was shifted back to a sufficiently safe distance. It is a question whether this would not yet be best and cheapest in the end. The great advantage looked for during the course of ages would be the re-arrangement taking place under a natural process, of much soil along the immediate banks.

The recently introduced system of river-training has made it possible for a man who thinks that his property has been injured by the alteration of the river, to institute an action at law against the irrigation department. Formerly a cultivator held his land at his own risk, but he had also the right to go down stream, even for hundreds of miles, and take up newly-deposited land equivalent to that which he lost.

Excess of Salt in Soil.

Salt begins to show wherever the surface of the soil lies low, and is insufficiently drained, as in the neighbourhood of the salt lakes, which appear as an irregular chain within the crescent-shaped ridge of low sandhills skirting the Mediterranean coast. After thorough drainage has been established, the salt may

be removed within a few years by repeated washing or "leaching" with water, applied to banked-in areas of limited size, so that the water can sink through the body of the soil, and find its way into the surrounding drains. The salts, often present to the extent of 10 per cent. in the surface layer, have been brought up by water raised by capillary action through the soil, and then allowed to escape into the air by evaporation. The water is another source from which the accumulation is in part fed, as the clear Nile water contains 17 of salt in 100,000 of water, but no injury need be anticipated from this amount if good drainage is provided.

The water of the Nile also holds in its volume, possibly in solution, an unusually large per-centage of air, of which oxygen forms a most important ingredient. It is, probably, more or less due to this circumstance that Nile water is so healthful and palatable, even at its reddest, and in spite of the fact that the river is not only the main water-supply channel, but also the great common sewer of the country into which all sorts of filth, including dead animals, are thrown. The average native prefers water in the muddy state, rather than after it has been filtered.

Cost of Pumping Water and Land Tax.

When a regular rotation is maintained under an extensive system of cultivation, the annual cost per acre for pumping and distributing water at the season when water cannot be had "free flow," is estimated at from £1 to £1 10s. per acre. This latter, added to a tax of 160 piastres, raises the first charge upon the land above £3 per acre. When free flow-water is delayed, for even twenty days, it not only adds to the expense of the cultivator for pumping, but the yield of crop is very seriously reduced, possibly, in the case of maize, as much as two ardebs per acre. Should the Nile not rise sufficiently to give a cultivator free flow in flood time, he is entitled to pay only half his usual land-tax for the area on which the water failed to come. The flood months are four in number, usually extending from the 8th of July till the 8th of November, although the time rate, and extent of the rising and the falling of the river, vary considerably one year with another, and often give rise to well-grounded anxieties.

Crop Seasons.

The crop seasons are divided into three very distinct and very different, yet highly productive periods, conferring upon Egypt a special advantage over most countries.

1. The autumn or "Nili" (1st August till the end of November), the period of flood in which maize, millet, sesame, and a few minor crops are grown.

2. The summer or "Sefi" (1st April to the end of July), the warm weather period, in which tropical and semi-tropical crops, such as rice, sugar, and cotton are produced.

3. The winter or "Shitâwi" (1st December till the end of March), or cold weather period, when the European crops, such as wheat, barley, and clover, grown in a temperate climate, come to maturity.

The two latter seasons correspond more or less in point of time to our own summer and winter, Egypt being like Great Britain, north of the Equator, but the mean temperature is considerably higher in Egypt than in this country.*

Introduction of New Crops and New Methods of Cultivation.

Cotton is one of the chief products grown for export, and consequently, directly or indirectly, is one of the great sources of surplus wealth, and also invaluable as the means by which the country is enabled to pay the interest upon a debt of nearly £100,000,000 sterling. It is a crop of comparatively recent introduction, since the development of canal irrigation. Together these important recent departures present the best possible illustrations of the absurdity of the ideas of those who hold that it is impossible for us to improve Egyptian methods of working, or to do good by reflecting the light of European science upon certain dark corners of Egyptian practice. It is not the case that the Egyptian is following in the footsteps of ancestors who have trodden the same path for thousands of years, as the most prevalent system of irrigation, and many of the most important crops have been completely changed by European influences since the beginning of the present century.

At one time flax was extensively cultivated because England wanted linen; since that fashion has changed, and cotton is preferred in our home market, flax has practically disappeared, and cotton has taken its place. The Egyptian will grow anything for which he can secure a ready market and a remunerative return. For example, who would have thought

* The mean annual temperature at Alexandria is 69° F., and at Cairo 70° F., London 50·4°, Edinburgh 47·1°.

a few years ago that Egypt would aid in supplying the London market, early in the season, with young potatoes!

FOOD.

The bread on which the working-classes chiefly live, eaten generally along with raw green vegetables of different varieties, is so hard that it is necessary to soak it in water before attempting to use it. In Lower Egypt the chief ingredient is maize, while millet, *Sorghum vulgare*, supersedes it to a large extent in Upper Egypt; the thinnings of these crops while the plants are young and green are invaluable for tiding the work cattle over a period of scarcity. Wheaten bread is reserved for the upper classes, and for men employed on large contract works, where wages are usually higher than the average of the wages paid to cultivators, but barley-meal finds a place in the food of the working fellahîn.

THE FELLAHÎN.

In spite of what appears to us a meagre bill of fare, the fellah is very often a man of splendid physique, superior in strength and in endurance to the Indian ryot, whom he strongly resembles in many of his ways of working, in his habits, in his stolid lack of nervousness, and absence of fear of sudden danger to his person.

It is generally believed that the fellahîn of the present time are almost exact reproductions of their predecessors for countless generations, and that although the country has been frequently conquered, the new-comers were in matters of numbers insignificant in proportion to the great mass of the people, and consequently became rapidly absorbed. It is also a common belief that the soil and climate, and possibly the Nile water, exercise an influence in producing a certain type; for example, the prevailing nut-brown skin of the native of Lower Egypt. That this is so is almost a certainty, but the direction in which the influence works is frequently misunderstood. The result is more probably brought about by natural selection—the survival of the fittest—than by the infinitely slower process, under any circumstances, of the modification in a given direction of the individual units of succeeding generations. Two simple illustrations will serve to support this statement. Although many negroes, male and female, with jet black skins and protruding lips, come down to Lower Egypt from the Soudan and the Equatorial provinces, and inter-marry with the paler skinned Egyptians, the introduction of black skins gains no permanent ground. The climate of the delta, especially towards the north, where there is most rain, is too cold for negroes, and their descendants, pure and half-cast, usually die of pulmonary disease within a few generations. Again, Europeans and strangers to the country generally suffer and die from typhoid fever in vastly greater proportions than natives, many of whom possess immunity from the deadly consequences of this loathsome disease, although living under most insanitary conditions. Natives living in country districts, and being more exposed to the sun than those dwelling in towns, are darker in shade of skin; but this is simply the artificial darkening brought about by the sun, and corresponds to the influence exerted by it on people with dark complexions in this country.

COLOUR OF THE SKINS OF CATTLE.

It was interesting to note that the vast majority of Egyptian cattle had brown skins, irrespective of the colour of hair, differing not much in shade from the skins of the people, a colour which is represented to a greater or less degree among Indian cattle. Black skins in cattle are not so prevalent in Egypt as in India, but a pure pinky-white skin so frequently seen in England, and found only on rare occasions in India, was not met with in Egypt.

FEMALE LABOUR.

The Egyptian women of the labouring classes work very hard. They draw the household water supply from the river or from a neighbouring canal, carrying it in large earthenware jars, of native manufacture, upon their heads. In addition to household duties, they also work in the fields among the crops, and one may frequently be observed leading out to water and such scanty pasture as may be found, the family gamoos or black-skinned buffalo, *Bos bubulus*, a typical representative of the native milch cow of Egypt.

CATTLE.

The horned cattle of the country, other than the buffalo, belong to the same species as European cattle, *Bos taurus*, but are of a variety peculiar to the country. They are powerful and well-formed for work, high and pointed on the top of the shoulders (which are not crowned with the fleshy hump seen in Indian cattle), and particularly well-developed crest on the upper neck where the yoke rests. The horns are short, blunt, irregularly set, and

frequently pointing downwards, the antipodes of the long, elegant, up-turned horns of the cattle represented in the tomb paintings of ancient Egypt. It would seem as if the ancient race of cattle had died out from some one or other of the deadly forms of cattle-plague which at intervals sweep over the country. The re-stocking of the country could not be accomplished by the importation of European cattle, as these contract a peculiar form of blood-disease, no doubt of microbe origin, and usually die within two years after being imported.

It is rather a remarkable coincidence that the two last great outbreaks of cholera in 1865 and 1883, were immediately preceded on each occasion by a deadly cattle-plague, which filled the river with swollen and putrid carcasses and the air with unwholesome exhalations, especially in the vicinity of such places as the Damietta whirlpool, which is formed by the current at the abrupt bend of the river, where carcasses remained floating for days together. Horses, buffalos, and red-cattle died in vast numbers in 1864, while horses escaped at the last great outbreak, indicating that the cause of death was most probably not the same on both occasions. Of such matters there is, however, little chance of finding reliable written accounts, and the question must be practically left to conjecture.

While the donkey and the camel are the great beasts of burden in Egypt, red cattle are the faithful slaves and companions of the fellahîn who work in the fields. Cattle till the ground, working in native ploughs strongly resembling in general appearance the Indian plough, and doing work very much like that of a grubber or cultivator.

Egyptian Method of Threshing Grain Crops.

Cattle are also employed to tread out the seed, and while doing so, to break down and prepare for fodder the straw of the grain crops which is, when grown in a hot country, hard, dry, and unpalatable in its natural condition. When ready for use, it is called "tibbin" in Egypt and "bhusa" in India, where a similar method of threshing is practised. So much improved is the straw prepared in this way, not only in texture, but in aroma and presumably in flavour, and so accustomed are the straw-consuming animals to it, that they will not eat straw in the unprepared state with avidity, or thrive upon it if they do eat it. The hoofs of the cattle are aided in the work of threshing by a sledge-like implement called the "norag," drawn by a pair of bullocks, and driven by a man who sits comfortably on a wooden seat erected upon it. Though when at work it looks exactly like a clumsy wooden sledge, it really moves on two sets of thin iron discs, strung on two axles "drawn at a radius" of 50 feet, to give the implement an inclination to turn easily inwards.

The native implement is of rude workmanship, and is made to do more effective work by weights placed on the top of the frame. An improved "norag," by Murdoch & Co., of Mansourah, has the additional weights placed on the axles to reduce friction, and thereby lighten the draught.

Handling the Grain.

The cost of threshing and winnowing by the native method is about 8 piastres the ardeb (5·44 bushels), or equivalent to about 4d. per bushel, besides absorbing inconveniently the working power of a farm. On the Government Estate Domain at Coorishea, extending to some 20,000 acres, 400 pairs of cattle are employed for sixty-five days in threshing the crops. Steam-threshing machines have been recently so improved that the work of separating the grain and making excellent "tibbin," can be accomplished at the rate of 3d. per bushel of grain, a saving of 25 per cent. on the cost of the native method.

But for the high price of coal—30s. per ton at Alexandria—the cost of steam threshing would be less. Apart from the saving of expense, enormous advantage is derived from the use of steam-power in the cleanness of the sample. Grain taken from the earthen threshing floor is filthy with lumps of Nile-mud, the droppings of cattle, and other impurities, which all tend to increase the expense of transit and lower the price of that shipped to Europe. A door is also opened for dishonest practices, as the donkey or camel drivers steal what they can for their own use or even to sell, and make up the weight by adding earth to the remaining bulk. Some low class dealers are also said to be guilty of adulterating grain in this way, thereby injuring the reputation of Egyptian products in the foreign markets.

Egypt stands much in need of grain elevators, such as are largely used in America, for storing grain and also for cleaning and grading it according to quality. Though the money for their construction might be raised by a company, the interests of the country demand that the management should be directly under Government inspection.

The improvement of the market condition of grain is one of the improvements which the recently established Tewfikieh College of Agriculture has been instrumental in demonstrating.

The Tewfikieh College of Agriculture.

The college was named in honour of the late Khedive (Tewfik Pasha), who took a special interest in its success. This institution had its origin in a desire which sprang up little more than two years ago in the Egyptian Government to develop the agricultural resources of the country by calling in the aid of science. The result has been a success far beyond the most sanguine anticipations. During the first year of its existence the college contained about 60 students, selected from about 300 applicants, and the numbers of the second, the current year which began last October, have not fallen off. A number of the sons of large land-owners have taken advantage of the instruction offered, and it is hoped by this means to spread in all directions a knowledge of improved varieties of crop plants, improved rotations, improved implements, and improved methods, not necessarily altogether new to the country, but deserving of being more widely known. One of the main reasons why the college met with the approval and sympathy of the late Khedive was, that of all the educational institutions of the country, it is the one which holds out a prospect to its students of being able to do something on their own account, or in private employment, and not to trust, as too many educated Easterns do in Egypt, as in India, to securing Government appointments, or, as an alternative, give way to despair and discontent, if, indeed, not to disloyalty. The college has been organised by Mr. Williamson Wallace, the present director, who is associated with an admirably qualified and practical staff of scientific experts in the various subjects allied to agriculture; and even at this early period of its existence, it would be difficult to find in any part of the world a more completely equipped institution of the kind.

In addition to commodious residence-quarters, laboratories, and class-rooms located in a wing of the magnificent old palace of Ghizeh, there is a farm of 300 acres, which serves to demonstrate, practically, the work of the lecture-rooms. The rental value per acre is £5 per annum, although the soil is rather heavy, and not of the very best description. Its value is enhanced by its being located about two and a half miles from Cairo, which proves to be a ready market, so that wonderful prices can be obtained for certain crops; for example, £25 10s. per acre for a patch of early second years' sugar-cane for eating purposes, and £5 per acre for the cobs of green corn (maize), which is only a catch crop, occupying the ground for a short period.

In addition to the regular routine work, in which irrigation and cultivation, involving the use of the common implements, play important parts, elaborate experiments are carried out to test the effects of the available descriptions of manure, and the qualities of varieties of crop plants, such as the extremely important cotton plant, so liable to suffer from adverse atmospheric conditions, from fungoid diseases and insect pests, and from a natural tendency to degenerate in quality. The college staff has an immense field for original research-work open to it, which has not been scientifically explored. The main object of the institution will be to show how improvements can be made upon existing practices and existing available means, not to introduce European ways and methods to any greater extent than is demanded by the natural alteration in practices brought about by the increasing attempt to grow products to be shipped to European markets. In addition to results of immediate value to the country, from a practical and useful point of view, we may look with confidence to other results, which will be of general interest to science, as the outcome of the private researches of such men as the staff of the Tewfikieh College is composed.

The Locusts.

The plagues which afflicted Egypt in ancient times have not yet wholly disappeared. In 1891, during the month of April, immense swarms of migratory locusts (*Acrydium migratorium*) arrived from the west—possibly from Tunis or Algeria—and threatened to ruin the growing crops. It proved to be the most serious attack during 40 years, chiefly because the locusts bred in the country—not a common practice with them—increased at an alarming rate. The Cyprus locust, which at times does so much injury in that island, differs from the species which recently visited Egypt, in being smaller and in not being migratory. In external form, the Algerian locust is remarkably like the Egyptian grasshopper; but the latter is of a dull green colour, while the locust

is of a bright yellow. The bright colour is distinctly a disadvantage in the struggle for existence, as is seen when the numbers have been greatly reduced by artificial means, for then the native birds make quick work in despatching the remainder. The rate at which increase takes place is marvellous, the whole cycle of events from eggs to eggs being only 11 weeks. The female lays from 90 to 99 eggs, about one centimetre long, and she buries them about 5 centimetres (2½ inches) below the surface. The young locusts emerge after twenty days hatching, and at fifteen days old they club together, and march in search of food. From this time, in increasing degree till they are five weeks old, they are most voracious and destructive; they even attack and devour wounded specimens of their own species. At the latter period they throw off the first skin and develop full wings. They are most easily destroyed before they take flight, and the most simple method is to drive them into open ditches about 1 foot or 18 inches deep before they are fifteen days old, and to fill in the earth and thus bury them alive. When older, they may be driven into heaps of maize-cane to which they run for shelter, the heaps being afterwards burned. For a short time during the most critical period of the recent invasion, as many as 100,000 men, women and children, were called out by the Government to help in the work under the Corvée labour system. They were offered two piastres a day, and in some districts it is said that the fellahîn refused to accept the money as wages, although they are supposed to have taken a portion in the form of a present. The campaign lasted for six weeks, and nearly all were killed before they were old enough to develop wings. The great lesson which has been learned is, that it is possible, by energetic means within the power of Government, to prevent the wholesale damage to crops which is associated with the uninterrupted progress of locust swarms wherever they settle in the country.

Egypt for the Egyptians.

The cry of "Egypt for the Egyptians," is a sentimental one, and implies a condition of things which it is quite impossible to establish, although European influence were entirely removed. Very few of the true descendants of the old Egyptians occupy positions of influence, or are capable of taking part in the government of the country. The true Egyptians are, at present, unfit to govern themselves; the governing classes, apart from the western Europeans, being Easterns of foreign birth, or foreign extraction—Arabs, Turks, Armenians, Circassians, &c. The pashas, and men of large means, usually belong to one or other of these classes. If Egypt were left to the Egyptians proper, all representing these foreign nationalities ought to depart as well as the Germans, the French, and the English. But no such thing is within the range of practical politics, and the combination at present existing is in some respects an extremely suitable one.

The magnitude and unworkable nature of the machinery which is employed in the conduct of foreign affairs, embracing as it does the representatives of the great European powers, is detrimental to the progress of certain needed reforms which are supposed to involve the existing interests of other countries. The internal government of the country, however, carried on by the Easterns who have made Egypt their home within comparatively recent times, associated with the representatives of Her Imperial Britannic Majesty, at present in the persons of Sir Evelyn Baring and his official cortege, is a combination which it would be difficult to equal in theory, and impossible to approach in its efficient practice. It is of importance to know that the leading men who have the best interests of the country at heart appreciate the efforts being made by the British to strengthen the positions which have already been established, and to extend and consolidate the influences in favour of law and order. It is quite evident that, if British influence were removed, some other foreign influence which, to say the least of it, would not be an improvement upon that of the present time, would certainly strive to assert itself. It is only those who fancy they have something to gain in the scramble for place and power which would occur during the period of change who now grumble and complain, not in behalf of the country, but in the interests of themselves. The combination of Eastern and English influences in the government of Egypt is happy in its results owing to two main causes:—

(1) The English connection lends stability and security to the Government and raises the general tone, which is distinctly defective if judged from our high moral standpoint, in all purely Eastern forms of government; while (2) the Eastern element moulds within certain well defined lines the English ideas to make them serve to the best advantage the requirements of the people.

More than one important instance could be given to illustrate the advantage which has been derived from the association with the British legislators of natives in settling great agricultural, irrigation, and other problems, which involved vast interests, and called for much intimate personal experience in at least a number of the men entrusted with their solution.

French Influence.

Another burning question in Egypt is the position and power of France in the councils of the nation. Although France abdicated her share of the supreme power in military matters in favour of England, she still retains a right to many important lucrative appointments, and guards her interests in a most jealous manner; but her prestige as a nation capable of giving solid or useful advice and support to an Egyptian Government thrown upon its own resources (if such were possible), is gone. The position of France in Egypt is more that of a troublesome thorn in the flesh of England than as an aspirant to any substantial connection with the supreme government of the country. As a rule, Egyptian administrators, from the highest to the lowest of those now in power, have lost faith in the power of France to aid them in view of the practical examples of the way, in which the French conduct their home government and manage their colonies; and, moreover, the recollection of the fact that it was while acting under French advice that Ismaïl Pasha contracted the greater part of the burden of nearly £100,000,000 of debt, does not tend to develop any sympathies which may remain in favour of French influence.

Many of the French officials in Egypt are in themselves excellent men, but the French Government interferes so much with the private actions of her officials that they are made, with few exceptions, political agents, whose freedom of action is handicapped, and whose first interests are in consequence not so much as they ought to be with the country or the Government which pays their salaries, but with France, or rather with the limited section of the French people who maintain a sort of half-masked bitterness of feeling against England, because she chances now to occupy a position which, in a weak moment, the ruling authorities in France forfeited without compensation or reward.

Development of the People.

Egypt is developing in the science of governing as quickly as a country could do which had for at least 5,000 years been subjected to the most perfect form of personal, single-handed despotism; but it must be remembered that the growth of the governing instinct in a people is like the growth of intellect in a race; it cannot proceed by leaps and bounds, and can only prosper under conditions which induce slow and steady progress. Such conditions will remain as long as British influence is dominant in financial and military affairs. The qualities which have made Britain great as a colonising and a governing nation in every quarter of the globe are the untiring unselfishness and the unwavering uprightness and devotion to duty which is displayed by British officials in every grade of the public service. The influence is most seen when brought into contact with Eastern forms of government, where the standard of morality, in almost every sense of the term, is immeasurably inferior to our own.

The Late Khedive.

At the time of our visit—autumn, 1891—Egypt was to be congratulated upon her good fortune in possessing a ruler who took such a prominent personal interest in the prosperity of his country, as the late Khedive, Mohamed Tewfik, the sixth sovereign of the dynasty of Mohamed-Ali. His Highness was a man of great penetration and sound judgment in national affairs, and did not shrink from his share of the arduous duties which fell upon him, as the ruler of a people undergoing the process of liberation from the unfathomable depths of mediæval darkness, and the baneful consequences of slavery and tyranny.

Egypt is the only Eastern nation in which there is complete religious toleration, and where land is provided by Government for cemeteries and for the sites of mosques or churches for all descriptions of religious bodies.

The Khedive Tewfik had a high appreciation of the efforts Britain has made on behalf of Egypt. An agreeable personal interview with his Highness led us to believe that one of the most solid foundations upon which his opinion of the British rested, was a well-founded conviction of the fact that, in the conduct of their own affairs, they never lose command of their better judgment in momentary excitement.

It is a most natural conclusion to arrive at, that a nation which is able to conduct its own business creditably is a most suitable one to

lend another a helping and unselfish hand when required to do so.

The Present Khedive.

His Highness, the young Khedive, Abbas Pasha, promises to possess the good sense and sound judgment of his late and much lamented father, Tewfik Pasha, and at the same time an amount of individuality and determination which will, under the circumstances, prove a blessing to him and to his country. He displays praiseworthy anxiety to become fully acquainted with his Khedivial duties, discussing with his Ministers all subjects of importance, so that he may form his opinions correctly.

There are three special subjects in which he is particularly interested, viz., the army, education, and agriculture, and, if I may be allowed to say so, his choice is most judicious, and is an excellent indication of the existence of those superior mental qualities which he is accredited with, and which formed such a conspicuous feature in the character of Mohamed Ali, the founder of the present dynasty. The efficiency of the army is, perhaps his special hobby. He is by no means a tyro in the profession of arms. He underwent a thorough course of training in Austria, and he has also, seen during his travels, the monster armies of Europe. He is personally a judge of army matters, and there is during his reign every prospect of an efficient army being maintained not as an incitement to war, but as the best possible guarantee of peace, which for many years to come will mean increased prosperity and increase of wealth to all classes of the community. His Highness has already given proof of his interest in education by providing classes for secondary education in the Government schools of Alexandria, and we may rest assured that his good deeds in this direction are not at an end. He has given ample proof of his interest in agriculture by establishing a model farm at his Palace of Conha, where he spends much leisure time in admiring his animals, which have been selected from the best strains of the native breeds. He even attends to the details of the dimensions of his cattle-sheds. In a word, he is a Royal farmer when he can spare the time from being a soldier and a statesman. The Khedive, with all this, possesses great personal dignity and composure of manner which becomes him well. The sudden and lamented death of the late Khedive was truly sad, but Egypt is fortunate in having secured as his successor a young man of marked ability, naturally endowed with a conspicuous portion of Nature's most valuable gift—sound common sense.

The prosperity of Egypt is now an established fact, and it is only necessary to deepen the ruts to make the way to still greater progress permanent; but this will require patience and an amount of time which it is impossible to estimate at present.

DISCUSSION.

Dr. Voelcker said every one must regret the absence of Professor Wallace, and especially anyone who had had the opportunity, as he had, of hearing the lantern slides which had just been shown on the screen explained by the Professor; but, knowing his great energy and zeal, they might be quite sure that nothing but absolute necessity would have kept him away. Anyone who knew anything of Indian agriculture, must be struck with the relation which existed between it and that of Egypt, there being many striking points of resemblance, though also marked differences. Taking the similarities first, it would be observed that both countries were largely dependent on irrigation; Egypt had a great advantage in the silt, which was of immense fertilising value, but which only occurred in certain of the streams of India. In Egypt, also, salts were met with in the soil, but were more easily removed, owing to the more abundant supply of water. He believed Professor Wallace held that these salts could only be removed by prolonged washing with water, but, where this was not available, as in some parts of India, other means had been tried, and with some hopes of success. As regards the crops and the food of the people, there were also similarities: the wheat was hard, dirty, and adulterated in Egypt as in India. In the cattle, the hump which characterised the Indian breed was changed into a crest. While there were these similarities, there were also great differences, which had an important bearing on the improvement of agriculture in the two countries. Whereas India was divided up into very small properties, the separate holdings in Egypt covered a much larger area, and there the improvements were more easily carried out, and there was more scope for the use of machinery. At the same time there was a great deal to be said for the native implements and methods of cultivation. The cattle were very good, not so the sheep; and attempts to improve them by introducing English crosses had been more or less a failure in both countries. With regard to the people also there were decided differences, the Egyptian *fellah* having apparently the advantage over the Indian ryot. Professor Wallace had a theory of his own with regard to the skins of cattle, with which he did not altogether agree, and he thought that the general opinion in India was unfavourable to the doctrine that all the cattle had black skins. It now appeared that in Egypt the skins became shaded down to brown, but

personally he did not think there was much foundation for this theory. He was rather inclined to deprecate the introduction of political topics into a paper on agriculture. He must again express his regret that Professor Wallace had not been present to describe the slides, more particularly those showing the enormous irrigation works now being carried out, and which were as important as many of the Indian ones. The native methods of raising water were also very ingenious, and reminded him of what he had seen in India, and which it puzzled the best English engineer to improve upon. He remembered in particular one instance in which at one special depth, viz., 25 feet, a pump which had been brought from Australia did a little better, but at every other depth the native machinery was more effectual.

Mr. SHEPHERD said he was largely interested in this question in connection with a large tract of land, not far from Alexandria, which was referred to by Professor Wallace in his former paper, but the experience of the company was as yet but limited. They had come to the conclusion, however, that the land was especially favourable for the breeding and fattening of cattle and sheep. He thought Dr. Voelcker was slightly mistaken with regard to sheep. He remembered the Professor saying that, at the Agricultural College at Cairo, English sheep had been introduced, and had proved a failure; but they had come to the conclusion that crossing with the native breeds would be successful. Their attempts so far at breeding both sheep and cattle had borne out this idea, but it had not yet been carried out on a sufficiently large scale to judge of its commercial success. A particular kind of clover was found to be a very good crop for breeding purposes, and helped to create a valuable manure. The growth of cotton had not yet been carried out as it might be, but it had been tried to some extent, and last year 160 acres of land produced about £900. The tract of land to which he referred was surrounded by railways, was near the sea, and also the canal, so that it was very favourably situated for emigrants, especially Scotch farmers.

Mr. THEODORE WALKER said any one who had lately visited Egypt and North Africa must have noticed the great difference there was in the cattle of places not very distant from each other, such as Syria, Palestine, and Egypt. In Palestine, the cattle were very small, about the size of donkeys, and usually black. In Egypt, all the cattle represented on the tombs had long horns, but he was told they had all died out, and it struck him that the present breed was very much like the Indian; they seemed strong and robust, and in form were much like the cattle of Morocco, only the latter had long horns and a very large dewlap. Every visitor to Egypt must be struck with the exceeding fertility of the country; there seemed no stones; it was all a rich loam, and it was surprising that with such rich land the people should be so exceedingly poor and wretched. He was pleased to hear that the country was improving under the English occupation, and trusted it would be continued.

Mr. R. H. REW regretted exceedingly the absence of Professor Wallace, and should have been glad if instead of political allusions they could have had some further information as to the points in which Egyptian touched British agriculture. He was somewhat surprised to gather that the average production of wheat per acre was something like 27 bushels, which was highly creditable. He should have liked to ask the Professor if he could explain in any way the falling off in recent years of agricultural imports from Egypt. He had not the figures with him, but he believed it would be found that of late years there had been a great falling off in the import of wheat, and all kinds of grain and flour; whether that was merely an accident, or there was any particular cause for it he should like to know, and perhaps Dr. Voelcker could throw some light upon the question. He believed there was a slight increase in the case of wool.

Dr. VOELCKER said he should be inclined to attribute any diminution in the exports to a larger use of certain grains in the country itself. He knew that in India, if the export of wheat were not profitable, the people would either cease growing it, and produce some other grain, or they would use more wheat themselves. So long as Egypt had the fertilising influence of the Nile, and the silt which it brought down with it flowed over the country, there was not likely to be any deterioration of the soil or lessening of the crop. The silt was infinitely more valuable than any form of manure which an English farmer could place on his land. At the same time, not having been on the spot, he could not speak with any authority on the question asked.

Mr. J. HUGHES said he had not heard any special reference made to the quality of the Nile water, or the mud, to which so much value was attached. Some twenty-five years ago, or more, he was associated with the late Dr. Voelcker in analysing samples of this Nile water sent over specially by the Khedive, and the details would be found in the *Journal of the Royal Agricultural Society* about the year 1865. There were two special points about it —one, that the water was very soft; and the other, that it contained a considerable quantity of nitric acid, the fertilising value of which was very great. The mud was equal, if not superior, to any manure, for the simple reason that it was a complete manure, containing the various elements of plant food, and in a particularly fine form, which was a great advantage. A short time ago, he had occasion to analyse some warped soil from the eastern counties, and was struck by the fact that not only was it in a remarkably fine state of division, but was

very rich in lime, potash, and so forth. He should have liked to know if Professor Wallace had made any experiments confirmatory of the results obtained twenty-five years ago.

Mr. SCOTT said the native methods of raising water were very interesting, but he doubted if they were as efficient as more modern appliances. Some centrifugal pumps had lately been introduced, and worked very well. They were generally fitted with straw-burning apparatus, so that the high price of coal did not interfere with their use.

The CHAIRMAN said they must all regret that Professor Wallace was not present to reply to some of the questions which had been raised, but perhaps he would be able to do so in the *Journal*. The conditions of agriculture in Egypt were so different from those in any other country, except perhaps India, that it was very difficult to make them clear to those who had not been in that country; but Mr. Wallace had performed his task with great ability, and had given them a most interesting paper. Two interesting letters had appeared in the *Daily Graphic* for the 13th and 19th instant, written by his old friend and fellow-sportsman, Sir Samuel Baker, in which he described Egyptian agriculture; and he would commend those letters to the attention of all who were interested in the subject. Most people had but a faint idea of the vastness of the irrigation works of the ancient Egyptians. Herodotus, for instance, mentioned the great artificial lake Mœris, 400 English miles in circumference, which was made to store water for lands which were not inundated by the Nile, and they might fairly suppose that vast tracts of land which were now arid desert, were in those days cultivated, and perhaps afforested. Now that the Khedive's Government had taken in hand such irrigation works as were shown in the photographs, and had employed distinguished engineer officers, who were thoroughly acquainted with the irrigation works of India, to carry out similar works, it might fairly be hoped that, before many years were over, much of the land now uncultivated might be brought under cultivation Irrigation was the first thing wanted, and the next manure; but this was supplied, at the same time, by the water of the Nile; and when cultivation and tree-planting increased, an improvement in the rainfall might naturally be expected to follow. He believed that, since the opening of the Suez Canal, and the development of trees and gardens at Cairo and elsewhere, the rainfail had sensibly increased. The amount was now said to be about eight inches per annum at Alexandria, and it would be very interesting to know whether there were any statistics showing what it was 20 or 30 years ago. No doubt moisture attracted moisture, and it was well-known that the disafforesting of countries such as Palestine and Central India had turned them into desert wastes. There was every reason to suppose that by means of irrigation works now being started, the cultivation of trees would be promoted, which would tend to increase the rainfall, and thus to further increase cultivation. He concluded by proposing a vote of thanks to Professor Wallace, which was carried unanimously.

Miscellaneous.

CONGRESS ON INLAND NAVIGATION.

The fifth International Congress on Inland Navigation will be held in Paris in July of the present year. The work of the Congress will be divided into four sections—(1) Construction and maintenance of inland waterways; (2) technical working; (3) commercial working and economical questions; (4) waterways in their tidal part. In the programme of the Congress the various points for discussion will be as follows:—(1) Consolidation of canal banks; (2) water supply of canals; (3) leakage in canals; (4) reservoirs; (5) stoppages on canals and canalised rivers; (6) traction on canals, on canalised rivers, and on free rivers; (7) tolls and fees on waterways; (8) conditions of inland navigation ports; (9) respective uses of waterways and railways in regard to transportation; (10) improvement of tidal rivers, including their estuaries. Two principal excursions are being arranged for; the first will comprise the canals in the north of France, the *Fontinettes* lift and the Dunkirk and Calais docks; the second will consist of a visit to the canals in the centre of France, the works for canalising the Saône and straightening the Rhône and the *Furens* reservoir near St. Etienne. Smaller excursions on the Seine, Marne, and Paris canals will be organised during the Congress. The Congress, which is under the patronage of the President of the Republic, will be opened on Thursday, 21st July, in the Palais de l'Industrie (Champs Elysées), and will last for ten days. The president of the organising committee is Mons. Guillemain, Inspector-General of Ponts et Chaussées. The reports of the meetings will be printed in French, English, and German.

THE SALMON INDUSTRY OF THE RHINE.

The taking of salmon is an important industry of the Rhine provinces, and is regulated by an international agreement entered into, in 1885, by Germany, Holland, and Switzerland. The treaty is binding for ten years, and further, from year to year, until twelve months' notice of its expiration be given by one of the contracting parties. The jurisdiction includes the waters of the Rhine and its tributaries from Schaffhausen Fall in Switzerland, downward to the sea. The United States Commercial Agent at Magdeburg says that some of the leading provisions may be summed up as follows. No dams, nets, or

other obstructions for catching the fish may be erected for more than half the width of the river at low water, measured in the shortest line from shore to shore; further, the nets must not be over 2·5 metres in breadth, and must be stationed from each other at a distance of at least equal to double the length of the largest net employed. The fishing season is closed in Holland from the 16th of August to the 15th of October, inclusive; from the Dutch-German boundary upwards from the 27th of August to the 26th of October inclusive. During this period each Government pledges itself to prevent salmon fishing under the pretext of catching other fish. Further, in the Rhine tributaries, where the breeding districts are found, and in the Upper Rhine itself, above Mannheim, salmon fishing is only allowed during a period of at least six weeks, some time between the 15th of October and the 31st of December, by special permission of the authorities, and this special grant is only given on condition that the row and milt of the salmon shall be assured to the various artificial breeding ponds and establishments. Measures are taken to protect and promote salmon propagation as much as possible. It is stipulated that all the natural breeding spots in the tributaries shall be kept free and open to the fish ascending the river. It is left to each individual Government to settle for itself the lesser details, such as minimum length, tax, fines, &c., and it is especially agreed that nothing in the compact shall be construed to prevent any Government, in its own judgment, imposing severer regulations. Finally, a supervising commission is appointed by each nation, empowered to convene in international conference from time to time. Although the catch of salmon in Germany is annually very considerable, and salmon, like trout, is one of the delicacies of the table, the canning and preservation of this fish has not assumed any great proportions. It is carried on to some extent, but it has none of the importance of the industry of the Pacific coast.

THE GROWTH AND PRESERVATION OF POTATOES IN NANTES.

In a Consular Report from Nantes, recently issued by the Foreign-office, and dated February 25th last, Mr. Pauncefote gives some notes on the growth and preservation of potatoes during the winter. He says that last year's potato crop was a small one, in consequence of the unusual dryness of the summer, and, for this reason, there was but little disease. Wherever there was any disease, the treatment by sulphate of copper proved perfectly efficacious; and this applied equally to all parts of France where Consul Pauncefote had visited, and in some parts the disease had been very bad. In no one case had it failed; and, in some instances, patches that had been dressed, after the disease had attacked a field, recovered, while the rest went bad.

The dressing used is 3 lbs. sulphate of copper to 20 gallons of water; but experts say that a still better one is composed of 2 lbs. sulphate of copper and 4 lbs. of lime to 25 gallons of water.

The best results are obtained by using whole potatoes, sound, of medium size, being careful to select those which show the finest germs (but, if very large ones are used, they are cut in two), and planting widely. What is said to be the best and most disease-resisting kind yet discovered is at present very costly, the price being from £8 to £10 per ton, while the ordinary kinds cost from 32s. to 34s. per ton: but these last are said in the district to be of excellent quality. Some remarkable results have just been obtained by a gentleman farmer, who is also a distinguished chemical engineer, and has been, for some time past, engaged on experiments in potato growing. He has succeeded in getting the enormous return of 42 tons per acre—without using any of the improved or expensive varieties—from the magnum bonum and other ordinary kinds grown in the country. The following is the process he adopted:—The point of chief importance seems to be in the selection of the seed, and the use only of the very best and soundest tubers, which should be of medium size, and planted whole. The ground must be dug or ploughed very deeply, so that the tubers may have plenty of room to develop themselves naturally and easily, and should be well manured with either farmyard or chemical manure.

Before planting the seed potatoes, they are steeped for twenty-four hours in a bath composed of sulphate of ammonia and nitrate of potash, of each 6 lbs. to 25 gallons of water. After taking them out of this solution, they should be allowed to stand for twenty-four hours before planting, so that the germs may have time to swell, and it is to the increased activity of germination produced by this bath that the enormous return is attributed.

Grain, especially wheat, treated in a similar way, is said to have produced highly satisfactory results; for corn, however, there should be added to the bath 2½ lbs. of sulphate of copper.

In the matter of preserving potatoes during the winter, the best plan is said to be as follows:—After picking out the diseased ones, they are placed in a dry building or cellar in a heap of a yard deep; they are given as much ventilation as possible, but the doors should be kept closed when the weather becomes cold, and during the winter they should be visited from time to time, and stirred with a shovel.

For badly diseased tubers the following mode of treatment is said never to fail in arresting the disease. Take them, as soon as possible after they are dug up, and dry them. Make a bath with water and as much lime as it will take up, put the potatoes into baskets and dip them for a few minutes in the solution, and dry them in the shade, stowing them away in the manner described above. The diseased part seems to solidify after this treatment, and does not

spread, while the good part continues perfectly sound, and can be used, without any bad results, for feeding animals, or even for table.

Notes on Books.

"THE GRASSHOPPER" IN LOMBARD-STREET. By John Biddulph Martin. London. 1892. 4to.

In this handsome volume Mr. Martin points out that Lombard-street has its legendary history : thus, number 68 is associated with Matthew Shore, the supposed husband of the ill-fated Jane Shore, and legend has even grown up around Sir Thomas Gresham and his family crest of the grasshopper. An absurd tradition has been often repeated, that Gresham was a castaway infant, exposed in a field, and discovered by a casual passer by, whose attention was attracted by the loud chirping of a grasshopper ; hence, when he acquired wealth and dignity, he assumed the grasshopper as his crest; the fact being, that the Greshams were a well-known Norfolk family long before the famous merchant's birth. Mr. Martin refers to Sir Richard Martin, who was called to the Livery of the Goldsmiths' Company in 1558, and in 1605 was the oldest alderman in the city of London. He was Master of the Mint and Lord Mayor in 1589. His arms were the same as those of the bankers, but it is not known that he was in any way connected with the "Grasshopper."

The authentic history of the famous house, which afterwards became the banking firm of Martins, commences in the second half of the 17th century. In 1677, 17 years before the foundation, in 1694, of the Bank of England, the house is mentioned in the "Little London Directory." At the end of this book is inserted a supplementary list of the "goldsmiths that keep running cashes;" and among them are mentioned "Chas. Duncomb and Richard Kent, at the 'Grasshopper' in Lombard-street." The Duncombe family was connected with the Greshams by marriage; and Charles Duncombe was apprenticed to the famous Alderman Edward Backwell, who is so often mentioned in "Pepys's Diary." The partnership between Duncombe and Kent was dissolved in 1688, by the death or retirement of Kent. Shortly afterwards, Richard Smith (b. 1659 d. 1699)—whose portrait by Huysman still hangs in the bank—took a prominent part in the management of the business. He engaged, as a clerk, Thomas Martin, who, after Smith's death, became partner with Andrew Stone. Their names are associated together in 1703, and from that time forward the business was mainly conducted by members of the two families, until 1852, when Mr. George Stone left the firm. At his death, on the 15th July, 1861, the Stone family became extinct in the male line, he being the great, great-grandson of Andrew Stone.

After clearing up the various difficulties connected with the history of the different partners, from Duncombe to the Martins and Normans, who now constitute the firm, Mr. Martin gives an account of the growth of modern banking, and full particulars of the alterations made at different periods in the occupation of Change-alley. These particulars are made clear by the insertion of several maps and plans.

REPORTS ON THE CULTIVATION OF THE SPANISH CHESTNUT. India-office. 1892. Folio.

This Indian "green-book" contains Reports on the use of Chestnuts for Food in Italy, by Sir Dominic Colnaghi, and P. Gavazzi and G. Maldifassi; on the "Cultivation and Production of Chestnuts in the Province of Asturias," by W. Pendleton; and on the "Chestnut Trees of Catalonia," by Don Ricardo Acebal. The historical introduction, by Sir George Birdwood, is full of learned information respecting the introduction of the chestnut and other trees into Europe. The chestnut is a native of Central and Middle Asia, and it appears to have been introduced into Italy between the time of M. Porcius Cato, B.C. 234-149, and of Virgil, B.C. 70-19, the latter being the first Latin writer to refer definitely to them.

The systematic cultivation of the chestnut tree, and its present wide-spread growth in the United Kingdom, is, as Sir George Birdwood states, "entirely due to the action of the Society of Arts at the end of the last and the beginning of the present century, in offering prizes to those landowners who showed themselves most zealous in forming plantations of the tree." It was hoped that by this means the building timbers of the country would be increased, but in this case the hope proved illusory. The popular idea that the roof of old buildings, such as Westminster-hall, were formed of chestnut has been shown to be erroneous. The wood really used was that of the chestnut oak (*Quercus robur*).

In 1864, Sir George Birdwood forwarded from Bombay, at the request of Prince Halim Pasha, sixty specimens of the finest forest trees of Western India for experimental cultivation in Egypt; and respecting the systematic naturalisation throughout Syria and Northern Africa of the hardy leathery-leaved dry season trees and shrubs of the coasts of Southern India he writes: "Strangely beautiful in the parched months of April and May are the frequent evergreen thickets in the island of Salsette, and elsewhere in the Concans, of mixed *bukuli* (*Ixora Bandhuca*) and *karunda* (the 'Corinda' of Anglo-Indian *Carissa Carandas*); the former with its terminal corymbs of of bright scarlet, and the latter with milk-white jasmine-like flowers and large plum-like berries, coloured in the degree of their maturity, from lustrous pea-green and purest ivory, through every tint of celestial rosy red to ruby crimson and glowing purple, and shining, in their gay varigation, against its dark, glossy foliage, as though it were an illuminated tree of fairyland, with all the fairy court

dancing in the charmed climate of its fragrant and refreshing shade. Wherever it blossomed and fruited in Northern Africa it would make a Paradise."

Referring to the spread of vegetation over the globe, Sir George Birdwood writes:—"Yet with all the enlarged knowledge placed at our disposal by modern botanical science, and with all the equipments of an empire, out-stretched over every quarter of the globe at our command, how little shall we ever be able to accomplish in promoting an interchange of economic plants between the East and West, and adding in this way to the happiness of mankind compared with the unstudied, casual, and almost unconscious transformation effected in the vegetation of the countries of the Mediterranean Sea, with such incalculable results in the increase of their material wealth and the impulse thus given, and still operative, to human civilisation by the propagation throughout them of the worship of the gods of Phœnicia and Greece." After referring specially to the vine, the date palm, the olive, the myrtle, and the rose, Sir George thus closes his introduction:— "It is impossible to stigmatise as superstitions beliefs and rites that conferred such enduring benefits on the world. But for them the civilization of Europe might possibly have never advanced beyond that of newer stone age, preceding the age of bronze ushered in with the westward advance of the commerce and religion of the Phœnicians, and it is evident, in view of the facts here adduced, that they were the divinely appointed means for working out, in the long-suffering patience of Providence, the eternal purposes of God toward man."

Obituary.

Sir JAMES ALLPORT.—Sir James Joseph Allport, who died at the Midland Hotel, St. Pancras, of acute inflammation of the lungs, on Monday evening, 26th inst., was a native of Birmingham, where he was born in 1811. In 1843, he became manager of the Birmingham and Derby Railway Company, from which position he moved, in the following year, to the Newcastle and Darlington Railway (subsequently the York, Newcastle, and Berwick Railway). After six years in the northern county, Mr. Allport accepted office on the Manchester, Sheffield, and Lincolnshire Railway, and remained in it for three years, when he became manager of the Midland Railway, a position which he filled for 27 years. It was during these years that this railway grew from a local line into a great trunk route, the extension to St. Pancras being completed in 1868. The most notable of the measures by which he endeavoured to render railway travelling cheap, comfortable, and expeditious were the running of third-class carriages on all trains, which was commenced in 1872, and the abolition of second-class carriages two years later. In his 70th year, Mr. Allport resigned the managership, and was elected a director of the Midland Company, and presented with £10,000. He was knighted in April, 1884. From 1865 to 1883, Mr. Allport was Lieutenant-Colonel in the Engineer and Railway Volunteer Staff Corps. He was also an Associate Member of the Institute of Civil Engineers, and a Justice of the Peace for the borough and county of Derby. Sir James Allport had been a Member of the Society of Arts since 1852, and on several occasions, when railway subjects were discussed at the Meetings of the Society, he joined in the discussions.

General Notes.

AUSTRIAN WINE PRODUCTION.—The Austrian Minisiter of Agriculture has recently published the figures of the wine production of Austria in 1891. In the official returns, no reference is made to Hungarian production. According to the statistics, the total quantity of wine produced amounted to 66,114,000 gallons, distributed as follows:—Lower Austria, 11,044,000 gallons; Styria, 6,490,000; Carniola, 2,112,000; Carinthia, 3,740; Tyrol and Vorarlberg, 4,048,000; Coast land, 13,904,000; Moravia, 3,212,000; and Dalmatia, 25,300,000 gallons. To have been absolutely complete, the returns should have included Bohemia, but the figures of the wine production of this kingdom are not of sufficient importance to materially affect the total. Comparing the total Austrian product of 1891 with that of 1890, it is found that the yield of last year was lower by 22 per cent. than that of the preceding one, a very serious falling off, more especially when it is considered that the deficit is getting larger every year, and the vintage of 1890 was by no means more than an average one.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 4.—J. N. SHOOLBRED, B.A., "The Bradford Corporation Electricity Supply." W. H. PREECE, F.R.S., will preside.

MAY 18.—Captain W. de W. ABNEY, C.B., F.R.S., "Colour Blindness."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 17.—WILLIAM SIMPSON, R.I., "Mud as a Material for Architecture in India and the East." General ROBERT MACLAGAN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

Professor PERCY F. FRANKLAND, Ph.D., B.Sc., F.R.S., "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." Four Lectures.

LECTURE I.—MAY 2.—Introduction—Study of micro-organisms — Microscopic examination—Principles of staining, &c. -- Cultivation of micro-organisms.

LECTURE II.—MAY 9.—Culture media—Methods of sterilisation—Pure cultivation—Special methods for the cultivation of particular micro-organisms.

LECTURE III.—MAY 16.—Practical results of recent investigations—Hansen—Alcoholic fermentation with and without oxygen—Carbohydrates fermentable by yeasts —Artificial sugars in their relationship to yeasts—Fermentations of milk.

LECTURE IV.—MAY 23.—Bacterial fermentations —New products resulting therefrom—Micro-organisms in their relation to agriculture—Nitrification—Fixation of atmospheric nitrogen by plants.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Percy F. Frankland, "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." (Lecture I)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Druce, "Small Holdings."

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Samuel Herbert Cox, "Dry Crushing Machinery."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Prof. Wm. Ramsay and Mr. J. C. Chorley, "The Distillation of Wood." 2. Dr. S. Rideal, "Notes on the Composition of some Indian Gums of known origin."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Sir C. Wilson, "The Past and Present Water Supply of Palestine."

TUESDAY, MAY 3 ... Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lectures.) Professor T. G. Bonney, "The Sculpturing of Britain: its later stages." (Lecture II)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Swinburne's paper "Electrical Measuring Instruments."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 4 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. James N. Shoolbred, "The Bradford Corporation Electricity Supply."

United Service Club, Whitehall-yard, S.W., 3 p.m. Lieut. F. T. Hamilton, R.N., "The Application of Electricity to Torpedo and other Naval Purposes."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 4½ p.m. Annual Meeting.

Obstetrical, 20, Hanover-square, W. 8 p.m.

THURSDAY, MAY 5 ... Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. J. Mueller, "Lichenes Epiphylli Spruceani." 2. Mr. W. F. Kirby, "Notes on the family *Saturniidæ*, with descriptions of new Species in the Collection of the British Museum."

Chemical, Burlington-house, W., 8 p.m. Ballot for election of Fellows.

Society for the Encouragement of Fine Arts, 9, Conduit-street, 8 p.m. Dr. G. W. Leitner, "The Fairy Land of the Pamirs."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Chemistry of Gases." (Lecture II.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Inaugural Address by the President. 2. Professor Alexander B. W. Kennedy, "Research Committee on Marine-Engine Trials: Report upon Trial of the steamer *Ville de Douvres*."

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, MAY 6...United Service Institution, Whitehall-yard, S.W., 3 p.m. Colonel F. J. Graves, "Military Education."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Captain Abney, "The Sensitiveness of the Eye to Light and Colour."

Junior Engineering Society, Westminster-palace-hotel, Victoria-street, S.W., 8 p.m. Mr. John Taylor, "Naval Construction at Poplar."

Geologists' Association, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m.

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Lieut.-Colonel Thomas English, "Condensation in Steam-Engine Cylinders during Admission."

SATURDAY, MAY 7...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. Dannreuther, "J. S. Bach's Chamber Music." (Lecture II.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,059. Vol. XL.

FRIDAY, MAY 6, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

GENERAL MEETING.

TEMPORARY ALTERATION OF BYE-LAWS.

The Council hereby convene a General Meeting of the members to be held at the Society's House, in the Adelphi, on Wednesday, the 18th May, 1892, at 4 o'clock in the afternoon, for the purpose of considering, and if thought desirable of passing, the following resolutions :—

1. That in accordance with the proposal from the Council, the Bye-laws be altered and varied in such manner that the Council shall be empowered, during the years 1892 and 1893, to appoint not more than six members to be Vice-Presidents or other Members of the Council in addition to those appointed under Bye-laws 79 and 84, and that the Council be empowered to determine the period or respective periods that members so appointed shall continue in office, not being later than the end of the Session commencing 1893, and that all Bye-laws which are inconsistent with such appointment and determination be suspended or varied.
2. That Bye-laws 8, 9, and 10 be suspended during the Sessions 1892-3 and 1893-4.

By Order of the Council,

HENRY TRUEMAN WOOD,
Secretary.

2nd May, 1892.

Bye-Laws 8, 9, *and* 10.

8. The Chairman of the Council shall be chosen from those Members of the Council who are of one year's standing at least.

9. The Chairman of the Council, after two years' service, shall not be re-eligible to the office for at least one year.

10. The Chairman of the Council shall deliver an address to the Society at its Ordinary Meeting after his election.

CANTOR LECTURES.

Professor PERCY F. FRANKLAND, Ph.D., F.R.S., delivered the first lecture of his course on "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries" on Monday evening, 2nd inst.

The lectures will be published in the *Journal* during the autumn recess.

UNION OF INSTITUTIONS.

The following institution has been received into union since the last announcement :—

Bootle Technical School.

Chicago Exhibition, 1893.

APPLICATIONS FOR SPACE.

Notice is given that applications can only be received up to Saturday, 21st May. Any applications received after that date will be filed, in case of any space becoming hereafter available, but will not be included in the allotment.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

HANDBOOK OF REGULATIONS.

A "Handbook of Regulations and General Information" connected with the Royal Commission has been printed, and can be had on application to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi. The Handbook contains lists of the Commission, of the various Committees,

and of the Colonial Commissioners, Synopsis of the Classification, General Regulations, Regulations of the British Section, Traffic Arrangements and Customs Regulations, descriptions of the various Departments, Abstract of the McKinley Tariff Rates, Description of Chicago and the Exhibition, and account of the routes to the city.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 26, 1892; Sir ROBERT G. W. HERBERT, K.C.B., in the chair.

The paper read was—

AUSTRALASIA: ITS PROGRESS AND RESOURCES.

BY SIR EDWARD BRADDON, K.C.M.G.

In the *Westminster Magazine* for January, 1780, is to be found "A Sketch of the Life and Services of the late Captain James Cook," which eulogises Cook as the compeer of Columbus, De Gama, Magellan, Hawkins, Drake, and Raleigh; which tells us of the vessels he commanded and other details of his expeditions; but which, strange to say, utters not a word about Cook's greatest exploit, viz., the practical discovery of Australia as territory suitable for English colonisation.

Indeed, the only approach to mention of the Australian continent to be found in this paper is in an extract from the oration made by Sir John Pringle, what time the Royal Society awarded Sir Godfrey Copley's gold medal to Cook: and this extract is to the effect that Cook had dispelled the illusion of a *terra Australis incognita;* and I may add that this medal was awarded not for Cook's discoveries, but "for the account which he had transmitted to the Society of the method taken to preserve the health of his crew."

It is, moreover, carefully impressed upon readers of this magazine, that Cook's expedition in 1772-4 "to complete the discovery of the southern hemisphere," was a failure. "It had long been a prevailing idea," says the author of this sketch, "that the unexplored part contained another continent," but, according to this narrative, Cook carefully sought for this continent in regions very remote from the locality where it was to be found; and the account of Cook's last voyage of 1776, which resulted in the great navigator's untimely death on one of the Owaihi Islands, says nothing that removes the impression that Cook failed from first to last to discover Australia.

In short, the *Westminster Magazine* of 1780 showed a degree of ignorance on this subject which must be regarded as astounding, even by comparison with the ignorance of things Australasian still discoverable in this country. From before the commencement of the Christian era, geographers had held by the belief that a continent must, for purposes of equilibrium, be in existence in the southern region, where or whereabouts Australia is. Before the time of Mercator, such a continent was charted tentatively. Old maps of 1531 and 1542 have marked upon them an extensive country south of the Moluccas named *Jave la Grande*, which agrees more narrowly with the position and extent of *Terra Australis* than with any other land; and, as the names of geographical features of this chart are Portuguese, it is claimed that they (the Portuguese) were the first discoverers. Dr. Lardner held that the Spaniards and Portuguese visited the north and east coasts nearly a century before that country was discovered by the Dutch. The French are said to have actually discovered this continent before 1531. And its discovery by the Portuguese explorer, Manoel de Eredia, in 1601, and subsequent confirmation of this, by the visits of other explorers between 1601 and 1770, when Cook landed at Botany Bay, are matters of history. Yet did the *Westminster Magazine*, in 1780, speaking of Cook's voyage of 1772-4, quote, without comment or contradiction, the opinion that it had "dispelled the illusion of a *terra Australis incognita*."

As a fact, Australia had been proved, prior to the date of that magazine, a very much discovered reality, even supposing that Manoel de Eredia was, in 1601, the first in the field. In 1606 it was rediscovered by the Dutch, and by Quiros, who named it *Australia del espiritu santo*, in honour of Philip of Austria. In 1618, Zeachen, a Dutchman, surveyed the north. In 1619, another Dutchman, Edels, surveyed the west coast. In 1622, the Dutch ship *Leewin* visited and bequeathed its name to West Australia. In 1627, the Dutch Nuyts and the English Carpenter surveyed the south and north coasts respectively. In 1628, De Witt came, and left De Witt's land in evidence of his visit. Tasman discovered Tasmania in 1642, under the impression—which survived in Australia until the discovery

of Bass' Strait, in 1797, and which still exists very largely here—that this was a part of the continent. In 1665, Terra Australia was renamed New Holland, by order of the States General, as evidencing that shadowy claim of the Dutch, which never came to be other than phantasmal. From 1684 to 1690, William Dampier explored the western and north-western coasts; in 1705, Captain Martin Von Delft, with three vessels, explored and named the north-western coasts; Willis and Carteret explored the continent in 1763-6; and, finally, Captain Cook landed at Botany Bay, on the 28th April, 1770, and took possession of Australia, or, as he styled it, New South Wales, in the name of King George.

Captain Cook's methods of discovery differed in two important particulars from those of his predecessors. (1) He took formal possession of the country, which no one else seems to have done, perhaps because no other had sufficient observation and foresight to see that it was worth possessing; and (2) he wrote for his Government a report which strongly recommended this newly-found territory for British colonisation.

On the 26th January, 1788, Governor Phillip founded Sydney, and the career of Australasia commenced. Born 104 years ago, Australasia is still in its infancy. What is the adolescence into which such a sturdy stripling may be expected to develop?

It is said that England hastened to colonise Australia in view to finding in that possession compensation for the colonies lost to her (and, be it added, *by* her) in America. But this does not appear a very plausible proposition—it certainly is not a convincing one. Cook took possession of Botany Bay in 1770; the American colonies were declared free in 1776. Only in 1788 was the first colony fonnded in Australia.

There is a striking contrast between the colonial empire that remained to England when the United States were lost to her in 1776, and that which now owns allegiance to this mother of nations. We had, during the 17th century, been eclipsed in this line of conquest by the Dutch, who had acquired Batavia, in Java, in 1610, Manhattan, now New York, in 1624, Cape Town in 1650, and Trincomalee and Chinsurah in India, through the Dutch United East India Company, chartered in 1602. During that century the Dutch vied with England for mastery of the sea; the names of Van Tromp and other bold captains of the States General were associated for Englishmen with defeat that Englishmen were not accustomed to; our forefathers were insulted by a broom hoisted on a Dutch vessel as an insolent signal, and the courtiers of Charles II., at Whitehall, heard, as Macaulay tells us, the roar of guns of an invading Dutch fleet. They had been, moreover, more active than any other power in exploiting Australasia.

When England lost the United States of America, she had little left to her but (1) India, with such very limited rights of sovereignty as the British East India Company had acquired by Imperial grant over Bengal, Behar, and Orissa, her recently conquered provinces of the Carnatic: and the town of Bombay, which came to Charles II. as the dower of his queen; (2) the West Indies, and (3) Canada, conquered in 1759, when Wolfe died on the heights of Quebec in the hour of victory, this conquest being confirmed by the Treaty of Paris, 1763.

When New South Wales was founded, there was in existence only one of the three great colonial groups that now mainly constitute what we know as Greater Britain, viz., Canada, which, at that time, was little more than the Province of Quebec; Australasia was being created, and the Cape of Good Hope was in the possession of the Dutch, until finally ceded to the English in 1814, having been first taken in 1795, restored at the peace of Amiens, in 1802, and retaken in 1806. In the three colonial congeries of States, where there are now over 10,000,000 of British English-speaking subjects, there were, in 1788, barely 10,000.

New South Wales, the mother colony of Australia, founded in 1788, with a penal settlement attached to it, and other signs and portents of Imperial dominion, started in a sufficiently modest way and encountered a full share of the trials and tribulations natural to early settlement in an unknown and savage country. It was not a wholly unpeopled land before the advent of the English, but the Australian aborigines had done nothing to make the way of the new-comers smooth for them, while they did a good deal on occasion to roughen it. The natives had no idea of cultivating the soil; indeed, they may be said to have had a natural repugnance to husbandry or incapacity for it which time has in no degree modified. Of a very much lower type than the South Sea Islanders, they lived very much the lives of beasts of prey, subsisting upon fungi, grubs, shell fish, and such animals as they could hunt down in the bush, with an

occasional dietary change when a man and brother made the meal. They were a people who had not yet emerged out of the flint age, and were little amenable to the influences of civilisation when civilisation other than rum came within their reach. They have, it is true, made concessions in regard to cannibalism: they do not eat each other; but, although they make fairly good stock-riders and shepherds, and have proved useful as trackers in the police, they are no more given to agriculture now than when Governor Phillip first reigned in Sydney.

I may dispose of the Australian aborigines here, and finally. They have in the past given trouble; even now there are occasions when those of Northern Australia treacherously slay the white settlers, or raid the white man's flocks and herds. But they have, as a rule, little or no influence on the life and destiny of the nation, and they are decreasing in numbers in spite of philanthropic efforts of the Government to preserve them. The Australian aborigines were, I imagine, never a numerous race. It was not to be expected of people who regarded each other as a possible meal to become so. The total number conjectured to have peopled the continent when the English first took possession of the country was 150,000; there are now about 58,000, whereof some are protected in Government asylums or refuges. In New Zealand there are of that vastly superior race, the Maoris, 41,523. In Tasmania, where the lowest type of all was found, there is no survivor.

Settled in a land which, until they came, had never yet been tickled by the plough, or laughed with a harvest, the New South Wales pioneers very early in their career experienced the direst privation; and from 1806 to 1810 gaunt famine stalked abroad in New South Wales and the more recently founded Tasmania, in consequence of floods of the river Hawkesbury, and subsequent failure of the wheat crop. The commencement of famine is, by one authority, put down as 1802, and he tells us how nobly the colonists of Port Jackson behaved to the famished and scurvy-stricken crews of the French vessels *Naturaliste* and *Géographe*, that sought shelter in that port. He tells us how "floods on the Hawkesbury had destroyed the wheat harvest, salt meat was exceedingly searce, and fresh meat almost unprocurable; yet so soon as the strangers' necessities were known, Government oxen were killed, and by common consent the ration of wheat issued to the garrison and inhabitants was reduced one-half, so that the scurvy-stricken crews might not want what was so essential for their recovery." This statement is made on the authority of a letter written by Baudin, who commanded the French vessels. Both he and Péron handsomely acknowledged the kindness they received, the affectionate care of Governor King, the courtesy and unremitting attention of the inhabitants, the generosity of the Government, and the absolute freedom accorded to their movements.

Verily, the conscript fathers of New South Wales proved then, as Australasians generally have since proved, that they had true old English grit in them.

It is with regret that I add, that Baudin's return for this unmeasured kindness was the seizure of Flinders when he put into Mauritius in distress a year or so later, and the appropriation of Flinders' log, charts, &c., descriptive of his explorations in the Southern Hemisphere.

As I have said elsewhere, those were very primitive times indeed in Australasia, and days when money, as well as provisions, was apt to fall short. In default of specie, goods and service—even service to the State—had to be paid for in produce or whatever substitute might be to hand. It is mentioned how, on one occasion, Governor King desired Governor Collins, of Van Diemen's Land, to pay for the carriage of despatches by a sealing ship by giving the skipper thirty salt-meat casks. Fortunately for those who kept the Government accounts, the days of rigid audit had not set in; but had there been a critical Auditor-General existing, one cannot but vaguely speculate as to the method of account which would have been adopted when the medium of exchange was indifferently an empty cask, or a bullock, or any other commodity that chanced to be forthcoming.

A curious chapter in the early life of Australasia was that arising out of the right of sovereignty which was claimed over this new colony and all the islands of the Pacific by the then all-powerful East India Company. This right was more than claimed, a strenuous effort was made to exercise it; and it is due to the interposition of Sir Joseph Banks that Australasia was not then and there recognised by the Home Government as the appanage and vassal of the East India Company.

It was in furtherance of this pretension that the East India Company, in 1794, sent Lieutenant Hayes, of the Bombay Marines,

to explore the coast of Van Diemen's Land and its harbours, and to return to India by the South Sea Islands and Malayan Archipelago. The Company held that their Royal charter secured to them an absolute monopoly of trade, not only with India and China, but with the entire East, including the whole of the Pacific Ocean. So exclusive were the privileges asserted, and so jealously were those privileges maintained, that, according to the East India Company, the colonists of New South Wales could not trade with England except by permission of the Company.

As late as 1806, the Company successfully resisted the sale in England of the first cargo of whale oil and seal skins, shipped from Sydney in the *Lady Barlow*, on the ground that the charter of the colony gave the colonists no right to trade, and that the transaction was a violation of the Company's charter, and against its welfare. It was urged, on behalf of the Court of Directors, that "such 'piratical enterprise' must be at once put a stop to, as the inevitable consequence of building ships in New South Wales will be an intercourse with all the ports of the China and Indian seas, and a population of European descent, reared in a climate suited to maintain the energies of the European character, which, when it becomes numerous, active, and opulent, may be expected to acquire the ascendancy in the Indian seas."

It was decided by the Lords Commissioners of Trade that the action of the colonists was an infringement of the East India Company's Charter; but Sir Joseph Banks interested himself on behalf of the colonists, and represented to the Court of Directors that, in future cases, the Lords Commissioners "are disposed to admit the cargo to entry, in case the Court of Directors see no objection to this measure of indulgence towards an infant and improving colony; and, further, that their lordships intend, without delay, to prepare instructions for the future government of the shipping concerns of the colony, on a plan suited to provide the inhabitants with the means of becoming less and less burdensome to the mother country, and formed in such a manner as to interfere as little as possible with the trade resources and prerogatives of the East India Company."

Marvellous are the changes which the whirligig of time has brought about in regard to these contending powers. In 1806, there was an all-powerful Company, with sovereign rights over millions of the people of Hindostan, which it exercised as autocratically as any tzar or kaiser, even to the extent of inhibiting the entrance into India of any Englishman without a license. A Company that, here in London, had its Court of Directors (not a mere Board), and had, at its court, its courtiers, suitors, and hangers-on, after the manner of some pinchbeck St. James's. A company that had, in India, an army and navy, and which was served there by men of world-wide fame, such as Clive and Warren Hastings. A Company, finally, which, when it wanted money from its Eastern Empire, did not seek it, as Australasia now does, unsuccessfully, by legitimate methods, but ordered it to be sent; this brave court, in one instance, it is said, wording its order in the Horatian lines, *Rem, facias rem; si possis recte, si non, quocumque modo rem.*

On the other hand, there was, in 1806, the "infant and improving colony," as Sir Joseph Banks described it, struggling for bare existence against famine and mutiny, and the many difficulties inseparable from the first settlement in a strange land, with a total white population of some ten thousand, and an external trade confined to whale oil and sealskins; no hope of getting money remitted for its use by any method whatever, and no great public servants to make it famous, except the early explorers, whose services had come to be forgotten, and Cook, who was remembered for other discoveries than that of Australia.

And now the all-powerful Company has, for thirty-three years, ceased to exist. Gone are its court, its army, its navy, its great proconsuls, and its despotic rule—so completely gone, that a generation has succeeded them which knows of those things only as ancient history. No longer can an Indian kingdom be wrested from its rightful owner by a forged treaty, or a Begum be made to ransom herself by more than her weight in gold; or a province be huckstered to enrich the great Company in England. Nawabs and Rajahs are no longer the abject feudatories of a sovereign trading corporation, and no more is it practicable to raise money *quocumque modo*, or to question the right of Australasia's colonies to trade with England without the Company's permission.

On the other hand, "the infant and improving colony" of 1806 has developed into the congeries of States known as Australasia, and, although only barely adolescent and still improving, is a power to be reckoned with. But although the provinces of Australasia

have now a trade of £140,000,000, although they have done some considerable shipbuilding, they have never carried their "piratical enterprises," as the East India Company styled their trade, into all the ports of China and India with the result, foreseen by that monopoly of piracy, of acquiring the ascendancy in the Indian seas.

I will indicate here by a few facts the slowness of the progress made, and the hardships endured, by New South Wales during the early part of her career.

On the 4th of May, 1790, every adult person in the settlement was put on a weekly allowance of 3 lbs. of flour, 1½ lbs. of beef, and 1 lb. of rice, children under twelve receiving half rations. The Governor (Phillip) had the same allowance, and officers invited to dine at Government House were required to bring their bread with them. This governor of Barmecide feasts informed a friend, "that he had lived in the colony for three years in the constant belief that he would some day perish of hunger."

In 1792, after four years, there were 208 acres in wheat, 1,180 acres in maize, 121 acres in garden stuff, and 185 acres of other land cleared. There were 105 sheep in the colony, valued at £10 10s. each, and 23 head of cattle, 11 horses, and several pigs.

In 1793 there fell upon New South Wales the blight of a sordid travesty of Cromwellian rule, which lasted until 1810. In 1793 the first act of the new Governor, Captain Grove, one time of the New South Wales Corps, was to transfer all authority hitherto held by five civil officers to the military officers of his late regiment. Fostered by Grove, the New South Wales Corps established for themselves a monopoly of trade, and especially of the sale of the then powerful medium of exchange—rum. They became known, indeed, as the "Rum-selling" corps. This justice-administering and spirit-retailing regiment were the terror of the settlers, and a scourge to the governors. Governor Bligh, who had quite a talent for creating mutiny, was deposed and deported by these imitators of Cromwell in 1806. Governors Hunter and King were harassed and defied by them, but in Governor Macquarie they found their master. He was the Constantine of this Prætorian guard that would have sold a diadem, as readily as rum, if there had been one. Immediately after his appearance on the scene the military rule of the New South Wales Corps was brought to an end, the regiment was ordered home, and replaced by the 73rd, the commandant cashiered, and the paymaster prohibited from living in the colony for eight years.

In 1795, new settlers on the Hawkesbury had 6,000 acres of wheat and maize under crop, and three rams and five ewes were imported, for which it is claimed that they formed the foundation of the sheep-farming industry of Australia. At that time prices ruled as follows: — A cow £80, horse, £90, sheep £7 10s., breeding sows £5, geese and turkeys £1 1s. each, ducks 10s. a pair, mutton 2s. a lb., goats' flesh 1s. 6d. a lb., butter 3s. a lb., green tea 16s. a lb., raw sugar 1s. 6d. a lb., and soap 2s. a lb.

During the first decade of the nineteenth century, *The Sydney Gazette*, the first Australian paper, appeared.

From 1810 to 1821 Governor Macquarie administered the affairs of New South Wales with admirable efficiency and success. During those eleven years the colony was quietly progressing, happy in that it had no history, and the esteem in which this governor was held may be, to some extent, gauged by the frequency with which one meets his name throughout Australasia. Now and again he said or did little things that irritated his subjects. The free settlers were annoyed at the extent of the hospitality he showed to those of the convict class. Doubtless, they resented his dictum "that colonial society consisted of two classes—those who had been transported, and those who ought to have been," but on the whole they were well satisfied with him, and named their rivers, and towns, and streets and harbours, after him accordingly.

From 1788 to 1803 New South Wales continued to be the one sole colony of the Australasian group. In the latter year Tasmania was founded, and Tasmania owes her position as the second colony in point of age to the fact that Port Phillip (*i.e.*, practically Melbourne) had been inspected and reported as unsuited for settlement.

Governor King is said, with some show of reason, to have been hurried into the seizure of Tasmania (then Van Diemen's Land) by the fear that that very taking person Baudin, after he and his crews had been nursed back into health and had taken his departure from Sydney, might be beforehand with him. My own impression, after studying the whole evidence, is that Baudin had no such design. At all events he made no effort in that direction, and left the field open to the British governor, whose lieutenants in a leisurely way took possession

of the "Garden Island" and started a settlement at Risdon Cove on the Derwent.

There was reason why this operation should have been undertaken in a leisurely way, in the condition of the local fleet, of which we read: "His Majesty's vessels in those seas were few in number, small, and often unseaworthy, and there was a constant difficulty in finding vessels that could be spared for any special service. Of those under Governor King's orders, the *Buffalo* was essential at Port Jackson, the *Lady Nelson* was off North with Flinders, the *Porpoise* (the only other ship of His Majesty) was away at Tahiti, salting pork for the necessities of the colony. But there was in Port Jackson a little armed schooner called the *Cumberland*, which had been built at Sydney a few years before for the purpose of pursuing runaways. She was only of 29 tons burden, it is true, but she would serve. This little craft was, therefore, hastily prepared for sea, a crew was selected, Lieut. Robbins, master-mate of H.M. ship *Buffalo*, was put in command, and in four days she was ready to sail."

But Lieut. Robbins' expedition was of the character of the up-hill march of the French King. He started to annex Van Diemen's Land; he halted at an island in Bass' Strait, turned into Port Phillip to find it was worthless, and then went back to Port Jackson.

Lieut. Bowen was the actual founder, and for some short time Commandant and Superintendent of the Risdon settlement. As befitted one with so expansive a title, he set out from Port Jackson for his satrapy with a fleet of two ships—the brig *Lady Nelson* of 60 tons, and the British whaler *Albion* of 326 tons. So, with his army of lance-corporal and seven rank and file of the New South Wales Corps, a civil service of three (including himself), six free persons and twenty-four convicts for subjects, one horse, ten head of cattle, about fifty sheep, a few goats, pigs and fowls, and six months provisions, Commandant and Superintendent Bowen founded Tasmania; and, curiously enough, another Bowen (Sir G. Bowen) fifty-six years later founded Queensland as a colony separate from and independent of New South Wales, at which time, as you may have heard from Sir George, there were 7½d. only in the public treasury of the new State.

Tasmania, founded 15 years later than New South Wales, and started in life as a convict settlement-at-ease to Botany Bay, very early in her career went through some of the roughest experiences of pioneers. In 1807, she shared with the parent colony the trials resulting from another flooding of the Hawkesbury and failure of the grain crop. Through 1808-9, the Tasmanian colonists made the intimate acquaintance of want and scarcity, if not famine; and, when relief came, in 1810, it was in the form of wheat from India. As for New South Wales, this is how General Macquarie, the newly-installed governor, reported of her condition, in 1810:—"I find the colony barely emerging from various privations and disabilities; the country impenetrable, beyond 40 miles from Sydney; agriculture in a yet languishing state; commerce in its early dawn; revenue unknown; threatened with famine, distracted by faction; the public buildings dilapidated; the few roads and bridges almost impassable; the population in general depressed by poverty; no credit, public or private."

Very early in their career, too, and for many years, the Tasmanian settlers suffered sorely from the treacherous and cruel attacks made upon the defenceless and isolated settlers by the native blacks, who resisted every effort to bring them within the pale of civilisation as obstinately as they resented the notion of keeping themselves entirely aloof from the white intruders. Doubtless, there were many errors, and some cruelty, on both sides, in the conflict that prevailed between the two races. On the part of the aborigines, the depredations, the raids, the murders of unarmed men and helpless women assumed such terrible proportions that, in 1830, the Government intervened. At a cost of £30,000, the Black Line was organised, with the object of forcing all the natives into one locality (Tasman's Peninsula), and with the result that a man and a boy were captured. £15,000 a head were expended upon these twain.

But, between 1830 and 1835, one philanthropist (George Robinson) accomplished, by kindly suasion, what all the force of the Government failed to achieve. He induced the remnant of this race to seek with him the asylum offered on Flinders Island; that remnant numbered 203 only. And, although these unfortunates were cared for with all necessary tenderness and forethought, they rapidly died out, and now there is no survivor of these people. They are as extinct, after 90 years contact with the English, as the moa or the mastodon.

If the Tasmanian pioneers did not experience, as New South Wales did in 1804, the

trials caused by an outbreak of the convicts, they were troubled a good deal through the first thirty years by the escapees from the Macquarie Harbour penal stations. Bushrangers of greater or less fame or infamy, and with greater or less leaning towards homicide as a casual amusement, roamed the land from "Brady's look-out" in the north, to other brigands' points of observation in the south, and east, and west. The peaceful settler who left his wife at morn in fear and trembling lest the blacks should spear her in the daytime, sat in his ingle nook at night fully alive to the possibility of a gun-barrel entering his window and the order to "bail up" reaching his ears from the bushranger outside. Happily, the bushrangers have died out as completely as the aborigines.

Tasmania's career as a subject province of New South Wales expired in 1825, when she was proclaimed an independent colony. She had turned to the fullest account the twenty-two years of her dependency; had so far progressed in agriculture that she was able to send 15,000 bushels of wheat to Sydney in 1816; had seen three public journals launched only to collapse; had built her first church; and had acquired a Supreme Court (1824), with a Judge from England. When made an independent province, she obtained a form of self government by an executive council of four members and a legislative council of seven.

Tasmania, happily, escaped from the distress that fell upon New South Wales in 1822, as a consequence of another flood in the Hawkesbury. Governor Brisbane distinguished himself in that crisis by directing the settlers not to pull up their cabbage stalks, but leave them in the ground to sprout again. Unfortunately, he distinguished himself in a more seriously compromising manner by attempting to depreciate the local currency—that last and worst expedient of incapable financiers—and this brought down upon him the censure and disapproval of the Home Government. But Brisbane lingered on in his governorship until 1825, when he was recalled in consequence of the dissatisfaction of the colonists. This was the first instance in which the Home Government admitted the right of Australia to have a voice in regard to the removal of an unpopular governor; and provided that this much be conceded, it should, I think, be admitted that the right of appointment rests solely with her Majesty's English advisers.

In 1823, New South Wales saw the last remnant and relic of her Prætorian guard disappear; the old military court was superseded by a supreme court, after the English fashion. Trial by jury was granted; and the Royal veterans, the waifs of the New South Wales corps left in the colony, were disbanded.

In 1824, New South Wales acquired her Legislative Council and freedom of the Press—a freedom that I may say has, with few exceptions, been thoroughly respected. In that year we find it noted that wool exports had increased from 100,000 lbs. in 1820 to 500,000 lbs.

In 1827-30, New South Wales experienced the first recorded drought of a serious character, and the needs of that colony had to be met by wheat imported from Tasmania.

In 1828, a census of the New South Wales population was taken, and her people numbered 36,598.

Having now glanced hurriedly at the early history of the parent colony of Australasia and her first scion, Tasmania, I will proceed to show, in their order of settlement, the other five colonies of the group.

1. New Zealand was first colonised from New South Wales, but I find two dates given in this connection—1814 and 1826; missionary stations had been established, however, as early as 1804. She was separated from the mother colony in 1840, from which year she was largely colonised from Great Britain by the New Zealand Company and others.

2. Western Australia was never attached to New South Wales. She was colonised from England as the Swan River Settlement in 1829, and a penal establishment existed there from 1851 to 1868.

3. Queensland, first colonised as Moreton Bay, and as a penal settlement attached to New South Wales, was made a separate colony in 1859.

4. Victoria was colonised by Tasmanians in 1834 as a part of New South Wales, and separated from her great rival in 1851.

5. South Australia, like Western Australia, has never formed a portion of the colony of New South Wales. She was colonised by British emigrants in 1836.

It is unnecessary, and, indeed, impracticable within the limits allowed to me, to follow the early fortunes of all these colonies. The early settlers in each, experienced in a lesser degree the hardships, perils, and occasional reverses that have been described as incidental to the colonisation of New South Wales; but these

may be left to your imagination. As to New Zealand, however, the case is different, as, indeed, is that colony different in nearly every respect from the continent of Australia. In its physical characteristics, its native population, its climate, its fauna and flora, New Zealand, justifying its position in another hemisphere, is essentially unlike Australia—so is its early history.

New Zealand was first seriously colonised by the New Zealand Company in 1840. Shortly after this somewhat grasping corporation had embarked on their colonial enterprise, Captain Hobson was sent out by the British Government to act as consul, and put some check on the Company's ambition, which, at that time, seemed to aim at sovereignity in this region. Captain Hobson shortly after his arrival proclaimed New Zealand a part of the colony of New South Wales, and it remained a dependency of New South Wales until November following, when it was proclaimed a separate British colony, Hobson ceasing to be consul and becoming governor.

But the English in New Zealand had to deal with a native people very superior to, and much more formidable than, the Australian blacks, and very shortly difficulties arose out of the not too clean-handed land purchases made by the New Zealand Company. In 1843, the Wairu massacres occurred, nineteen Europeans being killed in an attempt to serve warrants on the Chiefs Rauparaha and Rungiaiata. In 1845, Captain Fitzroy conducted a series of expeditions against the Chiefs Haki and Kamiti, with ultimate triumph to the British arms. In 1856, the Maoris set up a king, and demanded in his name the rights of government—New Zealand Home Rule in fact, and out of this movement arose a series of engagements in Taranaki that lasted over a year. In 1861, the Waikatoo war, directed against the claimants of sovereignty, was fought out. And the cost of the several wars in money alone was £10,000,000 sterling.

It may be safely assumed, and it is certainly to be ardently hoped, that there will be no further calamity of this sort. The Maoris, a people of high order of intelligence and many virtues, are thoroughly amenable to civilisation. They have proved this. They have shown that they are capable of worthily occupying a place, side by side with Englishmen, in the Legislative Assembly, or wherever the councils of the nation may be held, and with every year of intercourse the gulf that divides the whites from the coloured men is narrowing, and the old race antipathies are fading away.

It is estimated that when the English took possession of New Zealand there were 100,000 Maoris. In 1856 there were 65,000. In 1874 the number had dwindled down to 45,740, and it was said that the race was rapidly dying out. But recent figures show that while in 1886 there were 41,432, in 1891 there were 41,523, and that, therefore, it may be hoped that these interesting people are not to disappear, save by the admixture of races that has already commenced through marriage between Maoris and English.

Before leaving New Zealand, it should be mentioned that she was the first colony to embark in an heroic loan policy. In 1876, the Parliament of New Zealand adopted the following scheme, which was to be carried out by loans of some £10,000,000, viz.:—(1) Systematic immigration on a large scale; (2) construction of a main line of railway through the north and south island; (3) purchase of native land in the north island; (4) supply of water on the gold-fields; and (5) extension of telegraphic works. Sir Julius Vogel was sent home, in 1875, to negotiate £4,000,000 of this loan in England, and did so successfully. What, I wonder, would be the reception here at this time of any Australasian statesman who asked for a loan of £4,000,000, for any purpose whatever—even for public works of a decidedly reproductive character?

Fully responsible and constitutional government was conceded as follows:—Tasmania led the way, in 1855; New South Wales and Victoria followed in that year; New Zealand and South Australia obtained this boon in 1856; Queensland carried hers with her when she separated from New South Wales in 1859; and Western Australia acquired it in 1891.

Three of these seven colonies had been established by the British Government as penal settlements. Transportation to New South Wales was continued up to 1839, and to Tasmania up to 1853, both these colonies having made a strenuous fight to obtain relief from this incubus. In Western Australia, where no such opposition was shown, transportation lasted up to 1868. During the time that the system existed, there were transported to the three colonies 116,842 males and 20,139 females, or a total of 136,981, at a cost to the State of some £8,000,000.

Seeing that this total is equal to about 3½ per cent. of the whole population of Australasia, it might be assumed that there would be

in that population some of the taint of convictism. But this is distinctly not the case. Australasia is singularly free from that criminal class which in England stands out so distinctly defined from the general community. Criminals and offenders are there, as they are in every land where the law places restraint upon human action; but the crimes and offences committed are for the most part the consequence of an occasional lapse, and very rarely due to confirmed habit or life-long training.

It does not seem to me very difficult to explain this immunity from the heritage of convictism. There are two reasons for it that are conclusive to my mind (1), because the majority of those who were transported were not confirmed criminals, if, indeed, they may be styled criminals at all, but offenders to whom reform was as easy as it was welcome, and (2) because, as a rule, those who were beyond reform were also beyond anything like domesticity; liberty to them was not to be limited by the obligations due to any fixed abode or family. They wandered whither work was to be had. They went in rushes to the gold fields; the hollow log, or miner's tent, or farm out-house, where they laid their head was all the "home" they knew or cared for; and thus they went their way working for their daily bread—working out their salvation let us hope—doing but little harm to any man, and dying without an heir to any criminal instinct that may have been in them.

As to the first point, let me quote Sydney Smith, who closely studied this subject of transportation. This is what he says:—"Men are governed by words, and under the infamous term convict are comprehended crimes of the most different degrees and species of guilt. One man is transported for stealing three hams and a pot of sausages, and in the next berth to him on board the transport is a young surgeon who has been engaged in the mutiny at the Nore; the third man is for extorting money; the fourth was in a respectable situation of life at the time of the Irish Rebellion, and was so ill-read in history as to imagine that Ireland had been ill-treated by England, and so bad a reasoner as to suppose that nine Catholics ought not to pay tithes to one Protestant. Then comes a man who set his house on fire to cheat the Phœnix Office; and, lastly, that most glaring of all human villains, a poacher, driven from Europe, wife, and child, by thirty lords of manors, at the Quarter Sessions, for killing a partridge. Now, all these are crimes, no doubt, particularly the last; but they are surely crimes of very different degrees of intensity, to which different degrees of contempt and horror are attached, and from which those who have committed them may, by subsequent morality, emancipate themselves, with different degrees of difficulty, and with more or less success. A warrant granted by a reformed bacon-stealer would be absurd; but there is hardly any reason why a foolish, hot-brained young blockhead, who chose to favour the mutineers at the Nore, when he was sixteen years of age, may not make a very loyal subject, and a very respectable and respected magistrate when he is forty years of age, and has cast his Jacobin teeth, and fallen into the practical jobbing and loyal baseness which so commonly develops itself about that period of life."

Then as to another class of convicts—the agricultural followers of Swing, who resorted to rattening and machine breaking when the new threshing-machines were introduced; and as to the number of this class that fell victims to their violent outbreak, Sydney Smith writes:—"The law is up and the judge is coming. Fifty persons in Kent are already transported, and will see their wives and children no more. Sixty persons will be hanged in Hampshire. There are two hundred for trial in Wiltshire—all scholars of Swing! I am no farmer; I have not a machine bigger than a pepper-mill. I am a sincere friend to the poor; and I think every man should live by his labour; but it cuts me to the very heart to see honest husbandmen perishing by that worst of all machines, the gallows, under the guidance of that most fatal of all leaders, Swing!"

There were, in addition to the classes above named, others who were not, strictly speaking, criminals—mere jail-birds, *e.g.*, there were the misguided men who resisted by force the introduction of labour-saving machinery in factories; soldiers who, in a momentary ebullition of temper, struck or abused a commissioned or non-commissoned officer; and those too energetic and too previous people, the Chartists, who were transported for advocating six points, whereof three, vote by ballot, abolition of the property qualification for M.P.'s, and equal electoral distincts, have become integral parts of the British political system; while two others—universal suffrage and payment of members—have been very generally adopted throughout the British possessions.

Is it not reasonable to suppose that many of these unfortunates should have had the desire, as they had the opportunity, of reforming in

their new world, when for them reformation only meant the reverting to the principles in which they had been reared, and which, until a fatal moment, they had practised?

But it was by immigration of free men, not by transportation of convicts, that these colonies became peopled. Whereas, from first to last, the number of convicts sent out was 136,981 only, we find that the number that voluntarily emigrated from the United Kingdom was, to the end of 1872, no less than 1,020,502, leaving the emigration of the last 19 years (for which accurate statistics are not available) out of the account.

The history of Australasia's immigration policy presents some curious features. Sir R. Bourke, as Governor of New South Wales (1831 to 1837), introduced the practice of selling country Crown lands at 5s. an acre, instead of granting them free, as had been done there and in Tasmania. The proceeds of these sales, he, as far as possible, devoted to the promotion of immigration. But in this policy he encountered the opposition of his legislative council, and, at the end of six years, there was expended upon immigration £91,167 only, out of £439,652 realised by land sales. Sir George Gipps (Governor from 1838 to 1846) was directed by Lord Glenelg to raise the price of land to 12s., but he was at the same time instructed in the following terms:—"If you should observe that the extension of the population still proceeds with a rapidity beyond what is desirable, and that the want of labour continues to be seriously felt, you will take measures for checking the sale of land even at 12s."

From this it would appear that, in Lord Glenelg's opinion, the supply of labour diminished with an increasing supply of labourers. To-day immigration is opposed by some sections of the community for just the other and more rational reason, that labour competition increases with an increase of workers. This latter view was confirmed by the experience of that time, for, immigration being persisted in, the scarcity of labour ceased. But this policy was carried out in the face of much opposition on the part of the colonists, who urged that the Imperial Parliament had no right, under Lord Russell's Act, "for the regulation of the sale of waste lands in the Australasian Colonies and New Zealand," to make it compulsory on New South Wales to devote half of the proceeds of her land sales to immigration purposes.

Assisted immigration has now ceased in all the Australasian Colonies except Western Australia, Queensland having discontinued it only a month or two ago. From first to last, these colonies have expended upon this system £10,601,743, mostly out of revenue. But can it be said that Australasia is fully populated even now, when, upon its 3,075,736 square miles, it carries a population of a fraction over the unit per square mile?

Think of the size of Australia, with its 7,750 miles of coast line, and 2,994,019 square miles of territory. Extending from 10° 39′ south in the tropics, to 39° 11½′ south latitude in the temperate zone, and between the meridians of 113° 5′ and 153° 16′ east longitude, it is more than twenty-six times the size of Great Britain and Ireland, nearly six times as large as India, and only about one-fifth smaller than the continent of Europe. Then let us add Tasmania, an island something smaller than Ireland, and New Zealand, four times the size of Tasmania, and we have Australasia as the term is generally understood.

And over this wide expanse, stretching through more than 36° of latitude from the north of Australia to the southern extremity of New Zealand, there are, necessarily, many gradations of climate. In the north we find sugar cane, bananas, pines, and other tropical and sub-tropical products of field and garden; then for some thousand miles a succession of rolling downs and plains, upon which sheep and cattle flourish abundantly in teeming millions; then, interspersed with pastoral runs, wide stretches of arable land, upon which maize and wheat are grown, and vineyards and olive groves flourish, and so into the garden island, and New Zealand, where one meets with another England and Scotland, and all the fruits of the earth natural to the mother country, but in greater profusion, and mostly of superior quality.

And in all the period antecedent to the gold discovery in 1850, Australasia was given up to pastoral and agricultural pursuits, but more particularly to the former. Nature had there provided all but boundless tracts of grazing land, and sheep, especially in good seasons, improved and multiplied upon the runs. Whaling and sealing in the earlier days rivalled the pastoral industry in New South Wales and Tasmania, but they were for a time only; and now Hobart, which was the largest whaling station in the southern seas, has but two vessels left where once she had nearly fifty, while Sydney has, I believe, not one.

There were necessarily many fluctuations in

the pastoral industry in Australia, where from time to time droughts wrought havoc upon flocks and herds. At times, too, there was a glut of stock, as, after three or four good seasons, there is to-day. But to-day the colonists know how they may dispose of their surplus sheep and beasts, by sending carcass meat to England in the cool chambers of the large ocean-steamers. New Zealand has shown how this may be done profitably, and year by year has increased the number of carcass sheep exported thus, until she has reached something like 2,000,000 in the year. Australia has been doing this also for some little time, and will doubtless increase her exports very largely. But in the old time—the good old Arcadian time—when miners and railways, and progress were not, as for instance in 1838 to 1846, sheep were boiled down for their fat, and realised 2s. 6d. to 5s. each, while not many years before that their value had been £10 a head.

In that pastoral era, Australasia jogged along quietly, and I suppose contentedly, doing without the roads and railways, churches, schools, hospitals, libraries, mechanics' institutes, &c., that are now to be found, to a large extent, wherever there are people to be served by the conveniences of civilisation. In a humdrum sort of way these colonies prospered, population and wealth increased; and, as a set-off for the absence of those blessings above referred to, there was the absence also of that British investor, with his cry "you have borrowed too much."

In 1851 came the great awakening of this slumbering land. Gold was discovered in New South Wales in 1850, synchronously with the turning of the first sod of the Sydney to Goulbourn railway—the first line of railway in Australasia. It was also discovered in the same year in Tasmania. In New Zealand it was found as early as 1842. But little came of these discoveries at the time; and Victoria, where gold was found in 1851, immediately took the lead as a gold producing colony, and largely revolutionised the social and commercial conditions of the whole group.

In 1851, the gold raised in Victoria was of the value of £580,548; in 1852, the value rose to £10,953,936; and in 1853, it reached the maximum annual yield of £12,600,084. The output for the six years, 1852 to 1857, was £67,283,748, with an annual average of £11,213,951. For the four years, 1858 to 1861, it was £35,732,388, with an annual average of £8,933,097. For the ten years embraced by the above periods the gross output was £103,016,136, with an annual average of £10,301,613.

The effect of this discovery, when the richness of the alluvial fields came to be confirmed and widely known, was marked and far-reaching. In 1852-3, people flocked to the gold-fields of Victoria from all the quarters of the earth. South Australia was largely denuded of her manhood, and thrown back some years. Tasmania similarly suffered, over 22,000 adult males out of about 40,000 leaving her for the new El Dorado. But Tasmania was largely compensated for this exodus by the abnormal prices obtained from Victoria for her produce (£20 a ton for potatoes, and so on for other produce), which caused the value of her exports to rise from £665,790 in 1851 to £1,509,883 in 1852, and (the highest point yet reached) £1,756,316 in 1853.

From 1857, the annual value of the Victorian gold out-put declined, and has, with occasional slight fluctuations, continued to decline down to the present time. For the decade 1862 to 1871, the total output was £59,341,232, the annual average £5,934,123. For the decade 1872 to 1881, ths total output was £39,084,352, and the annual average £3,908,435. For the nine years 1882 to 1890, the total was £22,980,924, the annual average £2,298,092.

But Victoria well used the opportunity afforded to her, by the sudden accession of wealth and people brought to her in the palmiest days of her gold mining, and has not suffered her fortunes to depend upon the quantity of gold raised within her borders. In the heyday of her gold rush, she gave attention to the development of her industries; she soon became a rival of New South Wales as a manufacturing colony, and, like California, she shows, and has for some time shown, a steadily increasing trade, even in regard to exports, *malgré* the decline of her gold out-put, by many annual millions. For example, while Victoria's exports for 1853, when her gold out-put was £12,600,084, amounted to £11,061,544 in value; they were £15,302,454 in 1873, when her gold out-put had fallen to £4,809,670. Victoria's pastoral industry developed while her gold out-put was slackening. When gold was discovered in that colony the wool exports were of a value below £1,000,000 sterling; in 1860, they stood at £2,025,066; in 1870, at £3,205,106; in 1880, at £6,417,466.

Other colonies, notably New South Wales, Queensland, and New Zealand, have, since 1851, produced gold in quantity; the total production for the various colonies from the com-

mencement of the gold mining to the end of 1889, having been as follows :—

	Oz.
Victoria	56,250,798
New South Wales	10,050,960
New Zealand	11,625,028
Queensland	6,873,314
Tasmania	565,222
South Australia	273,441
Western Australia	135,492
Total	85,774,255

The production continues, and if the splendid alluvial fields of Ballarat and Sandhurst, and elsewhere, have been largely worked out, new discoveries of quartz reefs and alluvial ground are being yet made from time to time, nor is it outside the range of possibility that gold mining may yet do as much, or more, for Australasia than it has in the past.

Gold does not exhaust our list of mineral discoveries. South Australia has worked the great Burra Burra, Moonta, and other copper mines to her profit. Tasmania, New South Wales, and Queensland have, since the gold discovery, raised considerable quantities of tin; Tasmania having from 1873 to 1889 exported tin of the value of £4,711,890, while New South Wales and Queensland have sent forth tin worth £13,222,047. Then, in 1885, the wonderful Broken Hill Mines of New South Wales brought silver into the list of Australasian mineral resources, while, even later in the day, the West Coast of Tasmania was proved to be, as to some hundreds of square miles, one large and rich silver field. Magnificent seams of coal have been worked for years in New South Wales. And Queensland and Tasmania now produce a fairly good coal in quantity more than equal to local requirements. Iron is known to exist, and only awaits capital to develop it: and bismuth, asbestos, and other minerals of commercial value are there, with gems from zircons to sapphires.

The value of the gold raised in Australasia up to 1889, at a price slightly less than £4 per oz., is £343,000,000. Add to that the values of tin, silver, coal, and copper exported £80,000,000, and we have a total of £423,000,000 for minerals produced, excluding coal, &c., consumed in the producing colonies and unnoted in available statistics.

The gold discovery, which electrified the people into a new life, and caused an economical development that has been as lasting as it is favourable, created a difficulty that has caused at times much anxiety and a little trouble. Among the crowds from all nations that came to the Victorian gold fields, were some thousands of Chinese, and from that day to this these Celestials have been with us in Australasia, principally as miners on poor ground that would not keep a European; largely as market gardeners, in which capacity they have nearly established a monopoly, and in other lines of handicraft. And being with us they have leaped into fame, much against their wishes and interest, as the creators of a Question. That Chinese question which has afforded work for our legislators in the way of prohibitive and restrictive enactments; which has set our Supreme Courts and the Privy Council in motion, and has caused the statesmen of the seven colonies to meet in solemn conclave, for the discussion of the ways and means by which the Chinaman may be excluded from Australasia.

It was objected, in respect to this Asiatic, that in any very large number he was objectionable. It was feared that hordes of these Mongolians had come or were coming. An import duty (or poll-tax) of £10 a head levied upon each Chinaman, was in some colonies deemed insufficient to keep him out, and a duty of £100 was introduced; other drastic measures were adopted, not always with the complete sanction of the law tribunals of the colonies, and, in short, the Chinaman became worse than a menace—he became a bore.

And really there does not seem to have been any reason for this access of Chinaphobia. Statistics certainly do not provide it, for whereas there were estimated to be 43,000 Chinese in Australasia in 1859, of whom 42,000 were in Victoria, there were only 43,706 distributed over the seven colonies, according to the Census of 1881; and by the Census of 1891 it is shown that this number has declined by about 3,000. As to the number in Victoria, that was 12,128 in 1881, and only 9,377 last year. It is true that an abnormal number (2,049) entered the colonies in 1887, and hence the conference; but this was only the fifth occasion since 1861 when the annual arrivals exceeded 1,000, and the average immigration of the five years preceding 1887 was 619 only.

The population of Victoria, which was in 1851 86,825, against 187,243 in New South Wales, rose in 1861 to 540,322 against 350,860 for New South Wales. This sudden bound was, of course, due to the influx of people to the gold fields, the miners, and the suttlers who followed the great mining army. But an increase almost as phenomenal, and general to

all the colonies of the group, has resulted from the more progressive policy inaugurated in the golden era. Thus we find the population of Australasia recorded at 1,237,684 in 1861, at 1,923,195 in 1871, at 2,742,550 in 1881, and at 4,000,101 by the Census of 1891.

These increases of the people have been accompanied by the development everywhere of old, and the introduction of new, industries, Manufactures unknown in the early days have, since 1851, gone on, always expanding, until now the out-turn from local factories has an annual value of several millions, and to that extent makes Australasia independent of the outer world. Viticulture has become established as an important factor in Australia's industrial system, and against 3,435 gallons of wine exported by South Australia in 1860, we have for 1890 exports from that colony of 221,850 gallons, Victoria having exported 214,016 gallons in that year, New South Wales 48,480, and the united colenies, including Queensland and Tasmania, 486,247 gallons. And when the British public shall have come to appreciate at their true value the Tintara, Hermitage, Frontignac, &c., grown in those Antipodean vineyards, these exports will be increased indefinitely.

But the omniverous British public has already given all possible encouragement to Australasia's new trade of meat purveying. Now when the cattle of Australasia have increased from 2,302,327 in 1850 to 10,346,661 in 1890, and sheep from 22,186,833 to 114,141,893, the stock owner finds an outlet in the meat market of England; and there is little chance of the supply failing, however greatly the demand may increase.

Australasia, in short, has turned her resources to account, and is in the way to become, as regards food supplies, the Whiteley of the United Kingdom. Most dutiful of Britain's scions, she is doing more than any other to feed her mother. It is not now-a-days, as of yore, the mere supply of wool and corn. Australasia continues to provide these in quantity, her last season's wool exports having touched the value of £25,000,000. But now she is teaching Britain to look to her for wine, and corn, and oil, for meat and fruit, and the produce of the dairy. Tasmania has achieved a name in the English market for her splendid apples, New Zealand has commenced to supply us here with peaches, apricots and nectarines, that are also produced in Tasmania in perfection. Australia and New Zealand have established a butter and cheese trade with England. The irrigation colonies, Renmark and Mildura, have commenced to supply raisins, and promise to follow with other dried or canned fruits. In Australia there are awaiting the English demand, olives and their oil, with many another tropical and sub-tropical product; oranges and lemons are coming in number from the groves of Paramatta. And if need were, Northern Australia could supply this market with sugar, that is now largely grown in Queensland and New South Wales, and, the coloured labour difficulty being surmounted, will be more largely grown in future.

May I be permitted to employ in regard to this labour question the boast, "I told you so." On the 8th December last, I ventured, at the Royal Colonial Institute, to express my conviction that Australia's resources would not be wasted in those northern regions, if coloured labour proved to be essential to their due development: that when the exigencies of the occasion demanded it, the opposition to that class of labour would be conquered. It very rarely happens that prophetic statements of this sort are immediately verified. In this instance verification in part has come with exceeding promptness, for before two months had elapsed after that vaticination of mine, the Premier of Queensland proclaimed his intention to propose the reopening of the sugar fields of his country to the full tide of Kanaka labour,* and the Premier of South Australia had set out on a tour to India with the intention of studying the question of employing Indian coolie labour upon the tropical area of his country.

The importance of the Australian sugar industry may be gathered from the fact that now, while yet in its infancy, the area under cane has grown since 1871 from 13,975 to 71,368 acres (viz. Queensland, 50,922 acres; New South Wales 20,446 acres), the produce of sugar being in 1891 about 95,000 tons. Doubtless the northern territory of South Australia and Western Australia will, in the course of time, add to the area of production.

Now the wonderful progress in Australasia's material wealth, that is hinted at rather than described above, is mainly due to that progressive policy which has had among its consequences a very great enhancement of the Public Debt. Australasia, with what I believe to be an admirable spirit of enlightenment and self-sacrifice, has anticipated a century of

* Since this was written, the Queensland Act of Parliament for extension of Kanaka labour for ten years has become law.

lagging growth; she has bridged over an abyss of time, and, at a cost which she bears ungrudgingly, has given to this generation of men those advantages and comforts of civilisation that in the course pursued during the first half century, their grandchildren would not have witnessed and enjoyed. They have made Australasia richer far by every test, and more productive (not excepting agricultural produce) than Canada, which has 25 per cent. more people, and more than double the period of existence. Could she have done this without discounting the future? The answer should be "No." But the financiers on this side—the holders of those purse strings that are now close drawn against Australasian borrowers—will possibly leave that question unargued and unanswered. They will only say "you have borrowed too much," and shout *Anathema Maranatha!* upon the Australias as so many daughters of the horseleech—although at the worst they are only asked to lend with the certainty of regular payment of interest and the best security for their capital.

Should it not be sufficient for British investors to know that the capital they have advanced is safe, and has been employed with remunerative results? Of the Australasian debt of £185,000,000 no less a sum than £121,000,000 has been invested in railways, whereas if the capital sunk in railways of the United Kingdom were added to the National Debt of this country, that debt would be swollen by £897,000,000. There is this difference to the investor in the two investments, that while the capital he puts into Australasian railways gives a fixed return of, say, 3½ per cent., whether the railways pay or not, that put into the railways of the United Kingdom yields only such return as the profitable working of the lines may afford.

Supposing, for the sake of argument, that Australasian railways gave no net profit, they would be largely reproductive in that they yield what has been aptly styled a "hidden profit" greatly exceeding the net profit of the best paying lines. The hidden value represents the time and money saved in transport of goods, and the larger productive areas opened up by means of improved communication. It is a value that is appreciated by the colonist who pays interest on our loans, in that it obviously increases his wealth as well as adding to his convenience.

But as a fact Australasian railways do yield a net profit to meet in whole, or in part, the interest charge. Those of New South Wales and Victoria have thus paid over 3 per cent. All the colonies contribute something to this end. South Australian lines pay 5.32 per cent r more than the interest upon their capital cost.

Certainly South Australia offers a most hopeful example of what Australasian public works may do in this regard. Witness the following statement from the account of the Commissioners of Audit for June, 1891:—

Net interest payable upon loans		£751,295
Railways—net earnings	£606,820	
Telegraphs, say	25,000	
Waterworks	65,167	
Adelaide sewers (contributed out of rates)	13,352	
Balance of interest payable out of revenue	40,956	
		£751,295

What South Australia has accomplished will doubtless be achieved by other colonies as progress and opportunity serve.

It may be added that South Australia, Victoria, and other colonies, have expended some millions out of revenue upon railways.

South Australia is one of the three Australasian colonies that have the heaviest debt per head of population. Does not the above statement prove that what is called debt in her case is only capital wisely employed, and as to 95 per cent. so reproductive that it imposes no burden upon the colony.

New Zealand is another colony that ranks as most deeply indebted to the British capitalist. She was, at one time, the shocking example in this respect, and there were many in the neighbouring colonies who could see nothing but ruin—certain and inevitable ruin—awaiting the extravagant Maorilanders. But what have been the results of this daring policy? I do not question but that there have been times of anxiety, and struggle, and retrenchment, when, perhaps, New Zealanders lost faith in the policy of progress, but those times have been survived, and, always advancing by leaps and bounds from decade to decade, New Zealand now finds herseif flourishing, and able to hold her own comfortably without the aid of the grudging purseholders, who tell us we have borrowed too much, and tell us this all alike, whether we have borrowed at the rate of £60 per head or £40.

What was New Zealand among the Australias prior to that time when the forward

movement took place. In 1850 she stood lowest of all the colonies, save Western Australia, in regard to population, exports, imports, cattle, sheep, bank deposits, &c. In 1890 she stood second as to sheep, third as to wool exports and bank deposits, and fourth as to the other items named. Her population during that period increased from 22,108 to 626,658, or 28 times; her bank deposits (from 1860 to 1890), 19 times; her imports, 26 times; her exports, 53 times; her cattle, 29 times; and her sheep, 113 times.

But let me make the larger comparison of Australasia as she was in 1850 and 1890 respectively. In estimating the present condition of Australasia, I do not dwell upon the wealth represented by millions of acres of unalienated Crown estate, that have a prospective value far in excess of the total of the Australasian public debt, or the present value of the Crown estate in the form of railways and other public works, which is more than equal to that debt. Nor can I compare the private wealth of 1850 and 1890 in the absence of figures for the former period; but I may state that, by a careful valuation made by the Government statist of New South Wales, the private wealth of Australasia was, in 1888-9, no less than £1,129,000,000, or a sum six times larger than Australasia's national debt, and then I may leave the following comparative statement to speak for itself:—

	1850.	1890.
Debt	£57,917	£184,912,804
Population	648,133	3,532,050
Wool exports*	£2,836,514	£23,734,332
Total ,,	£4,763,594	£70,901,685
,, imports	£4,619,930	£68,495,581
Number of horses	183,892	1,613,585
,, cattle	2,302,327	10,346,661
,, sheep	22,186,833	114,141,893
Shipping, inwards and outwards ... tons	1,209,515	15,395,186
Bank deposits (say)	£6,000,000	£110,855,571
Savings (approx.)	£1,500,000	£17,312,795
Minerals exported	Nil	£14,122,117
Revenue	£1,201,068	£29,306,217
Railways (miles)	Nil	11,600

And as to this statement, I will only remark that the increase in stock of the colonies alone represents a value equal to two-thirds of the national debt; and that while one item of private wealth does this, the State railways give to the Crown estate an enhanced value of the like amount.

* Wool represented more than half of exports in 1850, but less than one-third of those of 1890, when they had increased eightfold.

If Australasia has husbanded her resources and increased her possessions—to some extent out of British capital—she has amply proved her purchasing power and her trade value to the mother country. In a return for the years 1879 to 1888, Australasia ranks third (next to the United States and India) among the consumers of British products. Of the total British exports, 9·57 per cent. were taken by Australasia, while Canada took 2·89 per cent. And in this connection, if we take Australasia's imports of British goods per head of population, she stands absolutely first in rank, with £7 10s. 10d. per head, Holland coming second with £3 7s. 11d., and Canada third with £2 9s. 7d.

In some directions Australasia has, as I have said, commenced her career as a manufacturing country. To that extent she has ceased to be dependent upon the United Kingdom for manufactured goods; and, doubtless, as she advances in her industrial career there will be expansion of this internal production. She will require fewer products of the United Kingdom then than now; but that difference will be compensated by the increased demand of the residue necessitated by an increased population, and it is impossible to foresee a time when Australasia shall be entirely independent of the United Kingdom in this respect.

But her dependence upon the mother country as a market for her ever-growing produce, her wool, and wines, and corn, and meat, and metals, must continue through all the ages; or, putting it the other way, the mother country must continue to be largely dependent upon Australasia for these products. There is here a mutual interest that must be a bond of union always, and one may hope, a sufficient inducement to the Government of this country to keep clear of any treaty with foreign powers that may impose the slightest restriction upon commerce within the Empire.

In her own interest, Australasia could not be otherwise than faithful in her commercial obligations, and loyal to the mother country that is her best customer. But, as a matter of choice, and on purely sentimental grounds, she is as loyal as any portion of the Empire; and English to the core, as no other colonial territory is, I say she is loyal by choice, because there is no pressure from without, as there is in the case of Canada, to quicken her loyalty; no power at her gates to make a close alliance with Britain the necessary alternative of separation: she is moved only by an honest love for the land of her forefathers, and a pardonable pride in those

great traditions of our race which she inherits in common with brother Britons all the world over. And, in spite of the empty talk of fifth-rate colonial politicians, and the equally vacuous babble of certain English critics, I believe this loyalty and this brotherly love to be enduring.

"But," says the financial critic, to these colonial brothers, "you have borrowed too much; and I will lend you no more." Putting sentiment aside, as something excluded from the region east of Temple-bar, is this just or business-like? Who was it that encouraged the Australias to borrow so largely, and led them on, by offering two or three millions for every million asked for? I answer, the critics who to-day charge us with borrowing too much. They are as guilty as any one, if guilt there be in the business. Their pockets were overflowing with money, to be placed at Australasia's disposal, two years ago; and then, with the suddenness of the lightning-flash (but not with such irradiation), they announced that their hearts and purse strings were closed to us. Surely there is injustice in such a *volte face* as this, without a note of warning, so that those to be affected by the change might prepare for it.

And it is, I think, a mistake, from a business point of view. The British public have put some £190,000,000 into railways and other State undertakings of Australasia, which, after all, only represent a portion of the enterprises required. They have encouraged the Australasians to push on with a vigorous progressive policy that has worked wonders already in increasing the national wealth. They have embarked with us in a course that has been proved to be a prudent one, and to which, owing to British encouragement, the people of Australasia stand committed. Can it be deemed wise to arrest this progress at a moment's notice, for the sake of reading the Australasian people a lesson of economy? Is it not, as far as British capitalists are concerned, a starving of their investments which they would not countenance if their money had been sunk in some undertaking at home, which they would not so readily adopt as to Australasian undertakings were it not that their interest is safe whether those undertakings give a direct return or not. Their capital and interest are alike safe, I am convinced. There is ample security for both in the facts and figures I have cited as illustrating Australasia's resources. But that does not entirely relieve the British investor from his obligation as such, and I may add that I feel confident that the generosity, sagacity, and rectitude that distinguish this purse-holder will ensure his good faith when he sees what his obligation is.

I have no time, nor is there occasion now, to reply to those critics who have recently impugned the credit of Australasia in every possible or impossible direction. They are of that class of warrior which begins the battle when the foe is stricken down, and their attacks bring them little honour and convey no discredit. But I may be permitted to say briefly, that in spite of much misjudged occasional criticism of the manners, customs, and morals of the Australasians, these people compare favourably with others of the English-speaking race, that in spite of much that has been said against Australasia's financial and political methods, honesty of purpose and a true spirit of altruism have, as a rule, regulated the management of her affairs. There has been a good deal of carping at the extent of the people's power, and the manner in which ministries have submitted to this. But it may be urged that while Governments here, as there, are the outcome of the popular vote, the people there, owing to the wider distribution of wealth, are as a whole more truly Conservative, and more directly interested in safeguarding existing interests, than the masses of the United Kingdom. Ministries there ordinarily dictate the public policy and lead the people. Ministries here occasionally are led by the people instead of leading them, and, it should be added, without any permanent ill effects to the common weal.

The Australias are just now suffering from depression that has spread over the greater part of the civilised world. They are, for the moment, regarded with less favour than they were two years ago; but they contain all the elements essential to a great career, and the four millions of Englishmen who are toiling there are building up an empire that shall be ranked in the time to come second to none of the possessions that constitute the British Empire.

DISCUSSION.

Sir SAUL SAMUEL, K.C.M.G., C.B., said he could add but little of interest to the very exhaustive, interesting, and historical paper to which they had just listened, but as his experience with regard to the colonies extended over a period of sixty years, he might be permitted to make a few observations. He went to the colony of New Sou Wales in 1832,

and at this time New South Wales was all Australia; Victoria, New Zealand, South Australia, and Queensland not then being on the map of the world as colonies. He recollected when the heavy traffic of Australia was done by bullock teams. There were no horse teams in those days, for the roads were so very bad that horses could not do the work. The mails were conveyed in a very rude way, and it took about four days to go 100 miles. This distance was now done in as many hours. In those times it took five or six months to go from England to Australia, while now the voyage was performed in as many weeks, and, by means of the electric telegraph, we are in daily communication. All this showed what vast progress had been made—a progress unparalleled in the history of the world. Unfortunately, he had not had an opportunity of seeing the paper before coming to the meeting, or he would have been better prepared to speak upon it, but still, he might say there was much in it of history which showed the marvellous progress made by the colonies. He noticed a reference to the indebtedness of the colonies. It was said that the debt of the Australasian colonies was £185,000,000. Now, what had been done with the amount thus raised? How had England benefited by it? In consequence of the absence of navigable rivers in Australia, it became necessary in order to provide for the settlement of the country that it should be covered with railways, and no one in his senses would suppose that these railways and other great public works could have been constructed out of the revenues of the colonies. This was impossible. The colonies then availed themselves of the facilities which were afforded for borrowing money in the mother country for the purpose of making these railways, and with the object of settling the surplus population of England upon the lands of the colony. What had been the result of all this? When he went there 60 years ago the population was 53,000, now it was over 4,000,000. These were people who had gone out from the mother country, settled upon the lands of the colonies, and made a trade for England which she would not like to part with. One result had been that the shipping of the mother country had largely increased. In 1819, there was a regulation in England that no vessel under 350 tons should be allowed to go to Australia; the people in New South Wales were so alarmed at this, because it would take so long to load a vessel of that tonnage, that they met in public meeting in Sydney and petitioned the Government to reduce the tonnage by one half. Now vessels of 5,000 and 6,000 tons were entering the port of Sydney every week. All this had been brought about by the instrumentality of borrowed money, upon which the people of the colonies were well able to pay the interest. A strange alarm had been created, though why no one could tell, and people were not so ready to invest in colonial stocks as formerly. He had great faith in the colonies, and in the honour and credit of Englishmen, who he was sure would never break faith with their creditors. He felt convinced that before very long the colonies would be able to borrow with the same facility they did a few years ago. It was a most insane alarm that had taken possession of the minds of some investors, and it was brought about in a great measure by mischievous people and a portion of the Press. All this would correct itself in time if the colonies were only quiet, and did not show too great anxiety to again come upon the market with loans. If investors held back, they would soon find that the result would be injurious to England herself, as the expenditure by the colonies in this country would be considerably diminished. He was not at all certain that English manufacturers were not beginning to suffer in this respect already. He hoped the English people would soon begin to realise that they could not have a better investment than in Australasian securities.

Mr. E. B. TREDWEN said he wished to point out the valuable nature of the security upon which British investors were asked to lend to the Australasian securities—viz., the security of the railways. When railways were constructed here they were constructed under Acts of Parliament, which limited the rates that could be charged, but in the colonies they were constructed by the State, and worked with the view of simply developing the country by inducing people to settle on the land. If the railways in the colonies had been constructed by private enterprise, there would not be the low rates which were at present charged, but rates would be charged so as to make the scheme remunerative. He felt sure that if the colonies had to realise their securities to pay their creditors, that the railways could be floated at such a price as would enable them to pay off the whole of their debts, because those who purchased the lines would be enabled to charge a rate for the carriage of goods which would at once show a remunerative profit upon the working. He thought this was a fact which ought not to be forgotten by English investors.

Sir JOHN BRAY, K.C.M.G., said, so far as Australia was concerned, he thought the colonists were too much depressed with the fact that they had not been able to float loans so successfully during the last few months as formerly, though, on the whole, he thought the money had been profitably invested both for the colonies and for the English people. Australians were English, and their interest was the same as the mother country. The railways had produced a net revenue of $5\frac{1}{2}$ per cent. after providing interest upon the money borrowed and for working expenses, so that they must be considered a good security for the money lent. No doubt the returns from a railway, to some extent, depended upon the season and the goods carried, but, upon the whole, he was convinced that the railways had been constructed with judgment for the benefit of the people

living in different parts of the colony, and for the advantage of those who had provided the capital. He trusted that the people of England would take greater interest in Australia than they had done in times past.

The Hon. J. MUNRO (Agent-General for Victoria) said the paper was a valuable addition to the literature of the previous history of the colonies, but he was much more interested in their present condition than in what occurred sixty years ago. He was not sure whether he understood Sir Edward Braddon correctly, but it appeared there was a mistake in the paper, historically, with regard to the borrowing of the different colonies, for, as he gathered, Sir Edward Braddon stated that Sir Julius Vogel was the first to borrow money on behalf of New Zealand.

Sir EDWARD BRADDON said the statement in the paper was that New Zealand was the first colony to embark on an heroic policy.

The Hon. J. MUNRO said that Victoria borrowed £10,000,000 for railway construction before New Zealand.

Sir SAUL SAMUEL said New South Wales had done the same.

The Hon. J. MUNRO said upon their loan Victoria had to pay 6 per cent., but the money had been made good use of. If the colony did not borrow any more, the existing contracts having been carried out, the result would be that she would cease to import, and British manufacturers would in consequence suffer thereby. He was quite sure that the Australian colonies, if they were simply cut off from the rest of the world, would be quite able to support themselves. They had a variety of soil, manufactures, and minerals, owing to which the colonies were quite able to get on without any assistance. It had been said that the colonies were extravagant in their borrowing, but taking the colony of Victoria as an example, it appeared that they had borrowed £44,000,000, and had spent £45,000,000 upon the construction of railways. About £35,000,000 from loans, and £10,000,000 from revenue. A greater sum than every shilling borrowed had been spent on railways, and yet they were told that they were going too fast in this direction. He was sure that those who said so did not understand the position. Had railways not been made, the land would have been unproductive. Of one thing he was convinced, and that was that there was no chance of the colonies ever repudiating their loans. In England, people were taxed in every direction, but in the colonies there was no such thing known as Income-tax, and in Victoria £450,000 a year was devoted to the making of roads. If the colonists were put to it they could increase the revenue very much indeed. For a population of but 1,140,000 a revenue of £9,000,000 or £10,000,000 was by no means a small amount, but if necessary this sum could be increased to over £10,000,000. If English people thought the colonies ought not to borrow any more money, they must share the consequence of so thinking with the colonies, for if money was not lent, the imports would be considerably diminished, the result being a serious loss to British industry.

Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., said that, although he very much regretted that this country was still without a Colonial Museum, this regret would soon be removed when the Imperial Institute was completed. The fact was that English people were rather afraid of the producing power of the colonies, and although they did not like to say so, because they knew they were their best customers, yet secretly they felt that the colonists were manufacturing on their own account, and with so much success that the middleman was first of all doomed, and, what was more, some of the manufacturers were doomed. The general opinion of Englishmen was that Providence had created the colonies in order to provide a market for home productions, and they did not like the idea of the colonies producing for themselves. They think it is improper, and accordingly are determined to stamp out all idea of a Colonial Exhibition. The English people were somewhat ignorant of what was going on in the colonies, but a few more papers like that to which they had listened that evening would go far towards letting them know what was going on.

Sir JAMES GARRICK, K.C.M.G., said, listening to the paper had reminded him of the great success which had attended the efforts of the Chairman in the inauguration of the colony of Queensland. At the present moment the colony was passing through a time of difficulty, but he thought the Chairman would remember that the colony, five or six years after its birth, went through a time of difficulty—far greater than that which now presented itself—but within a few years it arose from its difficulties and became exceedingly prosperous. In 1866, when they were much pressed, they had to have recourse to Treasury bills, and they went upon the market as ordinary borrowers, paying interest at the rate of 10 per cent. With the money thus obtained the resources of the colony were helped to be developed, and Queensland soon occupied the proud position of being one of the greatest colonies. If they had got into debt, England derived a great deal of good from it. The foreign trade of England had shrunk during many years, while the trade with the outlying portions of its empire had increased by leaps and bounds. Queensland itself had, out of a population of some 400,000 people, sent about 200,000 souls from this country with borrowed money, and this had been a most profitable investment, for the people had been amongst England's very best customers. They had built up a colonial trade for England

amounting to millions a-year, and if that trade were capitalised, a financier would tell them that the value was greater than all the money which had been lent. It was a very common thing to compare Queensland with some of the old countries, and to say that the debt was greater per head than in other places, but this was a fallacy, for it must not be forgotten that the colonies had no debt for wars. Nearly all the debt was a productive one, and in estimating whether a nation was indebted more than another it was fallacious to place the debt at so much per head. In the colonies the railways and public works belonged to the State, and this fact had been entirely overlooked by those who referred to the capitation debt. He did not say that possibly the Australian colonies had gone into debt a little too fast; they might have sought to develop the country at a greater rate than they ought to have done, but that was simply a question of rest. He knew no country in the world that would recuperate faster than Australasia. Part of their difficulties had been brought about by those of the South American Republics. The Anglo-Saxon was altogether a different person from the people who inhabited the South American Republics; and further, it must not be forgotten that rebellions and revolutions were unknown. If England were to impress the colonies with the idea that they were going too fast, the result would be that they would rest and grow strong. The colonies had no idea of repudiation. In fact they would tax themselves to the very last shilling in order to pay their debts. In future he had no doubt the colonies would endeavour to lean less on England than before, and one result of this would be that English manufacturers would suffer. The trade of England with the colonies had already fallen off. He was sure the colonies had enough energy and honour never for a single instant to lose sight of the engagements which they had made with their fellow-countrymen in England.

The CHAIRMAN, in proposing a vote of thanks to Sir Edward Braddon, said this was not the first occasion on which that gentleman had obliged the Society of Arts with a paper, and he trusted it would by no means be the last. The audience must have admired the able manner in which the paper was put together, as the long historical statement was interspersed with touches of dry humour, which made it extremely light, notwithstanding that it was loaded with statistics. During part of the time he (the Chairman) was Prime Minister of Queensland the colony was in difficulty, as had been stated by Sir James Garrick, but it very quickly recovered itself, and soon became again one of the most prosperous colonies. His own opinion was that English people need not have the smallest anxiety with regard to Australian investments.

The vote of thanks having been carried, was briefly acknowledged by Sir EDWARD BRADDON.

INDIAN SECTION.

Thursday, April 28, 1892; SAMUEL SMITH, M.P., in the chair.

The paper read was "Re-organisation of Agricultural Credit in India," by Sir WILLIAM WEDDERBURN, Bart.

The paper and report of the discussion will be printed in the next number of the *Journal*.

NINETEENTH ORDINARY MEETING.

Wednesday, May 4, 1892; WILLIAM HENRY PREECE, F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bamber, M. Kelway, Seleng, Jorehat, Upper Assam, India.
Griffith, Frank, Prujean-square, Old Bailey, E.C.
Grimes, Arthur John Luna, Telegraph Department, Bombay, India.
O'Connor, John, M.P., House of Commons, S.W.
Townend, James Hamilton, Haberdashers'-hall, Gresham-street, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Chorlton, Thomas, 32, Brazenose-street, Manchester.
Hill, Lieut.-Colonel John, R.E., Poona, India.
Holzapfel, Albert C., 57, Fenchurch-street, E.C.
Lowenfeld, Henry, 31, Lowndes-square, S.W.
Ryder, Charles, Gledhow-hill, Leeds.

The paper read was—

THE BRADFORD CORPORATION ELECTRICITY SUPPLY.

By JAMES N. SHOOLBRED, B.A., M.Inst.C.E.

In the early part of 1888, the Corporation of Bradford, responding to the expressed desire of a number of their ratepayers, decided to provide a supply of electricity, in accordance with the Bradford Electric Lighting Provisional Order, 1883, for that portion of the centre of the town which had been approved of by the Board of Trade, under the title of the "Compulsory Area" of the Order.

The preparation of the plans, and the superintendence of the works necessary to carry out the above decision, were entrusted to the

author, who, as the consulting electrical engineer of the Corporation, had acted as their technical adviser throughout the earlier stages, while obtaining their Provisional Order.

After mature and careful consideration, it was decided to adopt the system of continuous current, generated at low pressure, and distributed direct to the houses on the two-wire parallel arrangement (at first, at least), but this arrangement could, later on, with the increase in the demand as well as in the distance of the distribution, be so modified as to meet those requirements.

In arriving at this decision, it was felt that the "continuous" current offered a number of industrial applications, such as motive-power, electro-deposition, storage, and others, peculiarly suited to the needs of a manufacturing town like Bradford; all of which would have been excluded by the selection of the "alternating" current, limited only to lighting.

While, again, with the "continuous" current, the use of the secondary battery (not possible with the "alternating" current) afforded, not merely a large reserve of power for use during the night, and at such times of the day, when it was also not desirable to run the engines and dynamos owing to the smallness of the demand, but also a most useful regulator acting upon the steadiness of the supply, and counteracting, or mitigating, any irregularity in the action of the steam-engines and other parts of the machinery.

The value of such a reserve as the storage battery, in case of any interruption or diminution in efficiency, through the sudden stoppage of any portion of the generating machinery, whether designedly or by accident, can hardly be appreciated.

The financial economy, due to the batteries, in the working of the generating station is very considerable, since the generating machinery can be completely stopped during many hours of the night and of the day, with a very marked saving in wages, coal, and other similar matters, as against the compulsorily uninterrupted running of the machinery, during the whole twenty-four hours, which is imperatively demanded on the "alternating" current system.

In the selection of "low pressure," for the distribution of the electric supply, as against "high pressure" (usually, though not necessarily, associated with the "alternating" current) it was felt that the primary duty of a municipal authority was to safeguard the public from as much danger as possible in a matter of this kind, even if such immunity should have to be purchased by the investment of a little more capital in the works (a fact which was extremely doubtful).

In the selection of the generating plant for a central station, in the centre of a large town, the important consideration, after efficiency, is probably that of compactness, and economy of floor space occupied, as ground is necessarily very valuable in such situation.

For this reason it was here determined, after very careful consideration, to adopt a steam-engine of the inverted vertical type, driving directly on the same shaft, a shunt-wound dynamo, both being placed upon the same bed-plate; an arrangement which allows of as much as 3 horse-power indicated per square foot of floor space being obtained.

Nor has this economy in floor space been obtained by a serious increase in the speed of the engines. Of the three engines first laid down, each of 150 horse-power indicated, two (Willans' single acting) have a maximum speed of 280 revolutions per minute, while the third (Marshall's double acting) does not exceed 180 revolutions. The rate of speed of horizontal engines for the same work would probably have been about 120 revolutions.

Owing to the difficulty of obtaining water for condensing purposes (at a rate of cost which would have been sufficiently reasonable to have effected any economy in fuel), it was decided to make the engines compound and non-condensing, with an initial steam pressure of 120 lbs. in the steam-chest.

It should be borne in mind that, with the Willans type of engine, triple expansion can at any time be readily adopted (if water for condensation should become available) by the interposition of a third cylinder between the steam-chest and the present high pressure cylinder.

The distinguishing feature of the demand for artificial illumination is the very great variation in the amount of that demand, which differs not merely according to the season of the year, but also during each twenty-four hours, which again may vary considerably according to the conditions of weather which may prevail on any individual day.

To endeavour to meet these varying demands, with due regard to economy, where steam is the motive power, it is absolutely necessary to have types of steam-engines which are of different producing capacities, so as to ensure that, according to the rate of the demand, a type of a size so proportioned be used,

such as may be doing a large per-centage of its full capacity, and therefore may be working under fairly economical conditions.

Bearing this in mind, there have been added later on (as the demand for the supply increased) two other types, namely, two engines of 80 horse-power indicated each, and two also each of 300 horse-power indicated.

Furthermore, secondary batteries (which may be looked upon as the equivalent of a 50 horse-power type of steam-engine), have also been erected.

With these four types (representing dynamos having each a maximum rate of output of 200, 300, 600, and of 1,200 ampères respectively), it will be seen that most of the very varying conditions of the demand for an electric supply can be met under fairly economical conditions.

In order to provide steam for the engines, it was decided to adopt the type known as the Lancashire boiler, which was considered as the most useful and the most economical, where steam in large quantities was regularly required.

There were first laid down three Lancashire mild-steel boilers, each of 7 feet diameter, and 28 feet long, working up to 140 lbs. pressure per square inch, and nominally of 180 horse-power. These have been working very satisfactorily for nearly three years.

A fourth similar boiler is now being added; and a Babcock and Wilcox, 120 horse-power nominal, has recently been fixed.

As adjuncts to the boilers, by previously increasing the temperature of the water with which they are fed, there were added later on a Feed-Water Heater, in order to utilise the heat of the waste steam after it had passed from the engines, and then a fuel economiser (Green's), to utilise the heat still remaining in the smoke before it escaped to the chimney.

To the above generating plant must be added the various electrical instruments and apparatus of many kinds (such as switch-boards, and regulating boards with their rheostats), intended for the regulation, measurement, and control of the supply of electricity before it was passed to the town.

All these various apparatus, though each individually partook of the general character implied by its name, were specially adapted to the circumstances of the locality, as well as to the magnitude of the currents to be carried. One distinguishing feature of their arrangement being that all connected with the +, or outgoing, mains were grouped along one side of the engine-room, while all those connected with the —, or return, mains were relegated to the other side of the room; an arrangement which, in the diminution of the chances of accident, has much to recommend it.

Of course, the standard instruments for comparing the measurements of other instruments, as well as those for the testing of meters, and many others, were placed apart in the testing room, as far removed as was practicable from the ever varying influence of the different masses of iron contained in the engine-room.

A further addition to the generating plant was made in the beginning of 1891, in the form of a secondary battery (Crompton-Howell), composed of a set of 70 67-plate cells (including some reserve ones for testing meters, &c.), each of 1,000 ampère-hours capacity, and with a normal rate of discharge of 200 ampères. This rate of discharge may, however, with this type of secondary battery, be considerably exceeded for a comparatively short period without injury to the cells.

In the working of a central station, where a very sudden call in the demand may arise most unexpectedly (through a fog coming on, or from some other cause), the importance of possessing such an elasticity in the maximum limit of the rate of discharge is very considerable; and it has here proved of great value on more than one occasion.

In the selection of a type of underground cable, including its protecting covering, which shall comply with the various requirements of an underground main in a town, the following points, amongst many, should be borne in mind (apart from its being an efficient and well protected conductor of electricity):—

1. It should be compact in form and take up little room.

2. It should readily adapt itself to the variations in direction as well as in level, which are constantly demanded from it in crowded thoroughfares by obstacles, such as gas and water mains; house services, cellars, lamp-posts, &c.

3. It should be readily accessible throughout its *entire* length, and not merely at certain points, for the connection of house services, as well as for side streets and for testing purposes.

All of the above points (and there are many other important ones) should be of much weight: but of them all, probably the last-named (readiness of accessibility throughout the whole of the cable) is of the most practical value in the various street operations, which are constantly occurring with a central station supply.

After careful consideration, a type of underground armoured cable (resembling, it was afterwards found, that in use in Berlin) was decided upon. It consists of a copper conductor, surrounded by an insulating layer, generally, but not always of a fibrous nature, with a seamless lead casing drawn over it by hydraulic pressure, and with a layer of well tarred jute or hemp round the lead. Then comes the mechanical protection in the form of two wrought iron or steel ribbons, each about 1½ inches wide, and wound spirally round the cable; the two ribbons breaking joint with each other. Outside is another layer of well tarred jute, braided and finished off. The total diameter of such a cable would be about 3 inches, even if the conductor occupied one-third of that amount.

This cable is laid direct in the ground, the excavation being again filled in with earth. After about 6 inches in depth have been filled in, a rough, ordinary deal board is laid down over the cable, to serve as a warning, when encountered by a pick or shovel, that an electric main is underneath.

It will be noticed that in this type of cable, the armouring or protection from external injury is carried directly upon the cable, and that at any point in its length this armouring can be cut and removed, in order to make a connection, without any detriment to the adjacent parts thereof.

All joints, with the above described armoured cables, whether upon the main itself, or for a street branch, or for a house service, are enclosed in a cast-iron case (mostly in an upper and lower half), which, after the joint is made, and the whole closed up, can be filled in from the outside, with a waterproof composition, so as to make the whole of the interior into a solid mass.

The mains are laid, almost without exception, along both sides of the streets under the pavement, thus avoiding breaking into the street itself (where the paving is generally expensive), in order to form the house connections, as would have to be done if a single main only had been laid.

Cast-iron street boxes of various kinds, to suit the several forms of connections, and placed under the pavement, complete the system of distribution, and afford ready facilities for movable attachments, whereby testing and other operations are much facilitated.

A site belonging to the Corporation, and containing about 1,200 square yards, and which is capable of considerable extension, was selected for the central station. Although in the middle of the town, it is outside of the compulsory area, selected to be first supplied with electricity.

On this ground the necessary buildings were erected. These were larger than was at first required, so as to admit of a considerable increase in the generating plant being placed within them. But these buildings themselves form only a part of a much larger building, which is now in course of construction—so rapid has been the development of the demand for the supply of electricity.

At the time of the commencement of the supply to the public, September 20, 1889, the following generating plant had been installed:—

Three Lancashire steel boilers, of 180 horse-power each; two Willans central valve steam-engines, each of 150 horse-power indicated, II. type; one Marshall double-acting steam-engine, also of 150 horse-power indicated; three Siemens shunt wound dynamos, each of 120 electrical horse-power (150 volts and 600 ampères), each dynamo being coupled to and driven direct by one of the above engines. Also, electrical boards and other apparatus necessary for controlling and regulating the supply to the town.

Since that time there have been added:—

In 1890, one Willans' engine of 300 horse-power indicated III. type, driving a Siemens' dynamo of 240 electrical horse-power (150 volts and 1,200 ampères); and in 1891, another similar Willans-Siemens set, and two sets each consisting of a Willans' engine of 80 horse-power indicated G G type, driving a Siemens' dynamo of 60 electrical horse-power (150 volts and 300 ampères), as well as a feed-water heater and a fuel economiser.

Early in 1891 there was erected the secondary battery of 70 Crompton-Howell cells of 1,000 ampère-hours capacity.

As regards the distributing system in the town: while at the commencement of the supply about nine miles of mains were laid in the streets, by the end of 1891 the total length had increased to 18 miles.

The motive power, as may be seen from the preceding statement, had about trebled, increasing from 450 indicated horse-power to 1,200 indicated horse-power; while the maximum rate of nightly output, from 1,400 ampères, at the end of 1889, had increased to a rate of 3,500 ampères at the end of 1891.

While the boilers and pipework had been constructed and laid down by Messrs. Holds-

worth and Son, of Bradford, and had given every satisfaction, the remainder of the work (exclusive of the secondary battery), but including the steam-engines, as well as the entire of the electrical work, both at the station and in the streets, had been supplied by Messrs. Siemens Bros. and Co., Limited; not merely of the original works, but also of the very considerable extensions that followed. Proving thereby, in the continued confidence which the Corporation reposed in them, and in Messrs. Willans' engines, how thoroughly and how efficiently the entire of the works had been carried out.

The secondary battery was supplied, and fixed by Messrs. Crompton and Co., Limited; and it is only fair to say, that so far it has given every satisfaction, and that it has proved itself a most valuable aid in the working of the supply of electricity.

The buildings, inclusive of their foundations, which are very heavy, owing to a portion of the site being upon the bed of a disused branch of the Leeds and Liverpool Canal, were built in a solid and efficient manner by Mr. Wm. Johnson, of Bradford; and they have proved, so far, well adapted to their work.

Cost of Working during 1890 and 1891.

The public distribution of the supply of electricity commenced on September 20th, 1889, since which date it has been carried on uninterruptedly. But as the working of the installation did not pass into the hands of the Corporation from those of the contractors, Messrs. Siemens, until about two months after, it will be convenient for the purposes of this paper to take the commencement of the regular working as from January 1st, 1890.

For the first few months the daily duration of the supply was from an hour before sunset to 11 p.m.; then, owing to a request for an extension of the hours of supply, it commenced at 10 a.m. and lasted till 11 p.m.

In February, 1891, the secondary battery already referred to having been fixed, the supply was made uninterrupted throughout the 24 hours; and it has continued so ever since.

It is well-known that the nature of the demand for the supply of light (that is, as to the time when it occurs, and as to the duration of such demands) depends very largely upon the character of the district. The one here supplied may be described as a "shop" district, with a few moderate-sized hotels in it, but without any private residences. Latterly, however, these characteristics have been somewhat modified, owing to extensions which have taken place into a neighbourhood where "warehouses" largely prevail. This term in the North of England is applied to a more ambitious building, both in its external appearance and the uses which it is put to, than a mere receptacle for goods and articles not in actual use, and does not include an office, nor possibly a resident keeper of the building.

A number of daily curves, some of which are shown in Figs. 3 to 7 (pp. 636-7), illustrate fairly the nature and extent of the lighting during that portion of each of the months selected, both in 1890, and on the corresponding day of 1891. Most of these curves are on a Saturday, which evening was, for some time, one of the heaviest in the week; but now is one of the smallest in demand (owing to the warehouses above mentioned not being on).

There is, even now, a certain amount of lighting during the day, due to basements of restaurants and of other buildings; this demand, of course, varies with the nature of the weather—if dark, foggy, or otherwise.

But there is another source of demand which is beginning to arise—that for motive power, for which a considerable field would appear to exist in Bradford. Where, dependent upon, and resulting from the larger manufactures of the town, are a number of much smaller industries, where mechanical power is needed, in quantity ranging from small dimensions up to that of several horse-power, a few of these electric motors have been fixed; some even up to twenty horse-power. They are used for hoists, lathes, and various other industrial purposes.

Then, again, electro-plating, a trade hitherto unknown in the town, has been started in one, if not more, establishments. I need not speak of the experiments which the Corporation are trying with the tramways, for the substitution of electricity for the steam-power at present in use; horse-power being quite inadmissible (except on one line), owing to the very steep inclines, which are constantly occurring. As steep as 1 in 15 (and even more so, in one or two cases); as well as to the great length of the inclines, averaging perhaps 1 in 30 to 40, for over a mile or more, without a counter-gradient to relieve them.

It is evident, therefore, that a very considerable demand will, before long, arise from the causes just enumerated, and that it will,

in great part, be a day demand, and also one which will arise in summer, just as well as in winter.

What a material advantage, financially, such a demand will be to the present working of the installation (successful, as it undoubtedly has been), a mere inspection of the lighting curves will show. Bearing in mind that this addition comes in to assist the weakest portion of the light curves—the daytime, and in summer too.

A mere glance at the daily curves for the latter part of 1891, will show what an important saving is effected each night by the use of the battery; instead of having to run the engines all night through, with so small a load as to be wholly unremunerative.

With respect to the working of the installation, much may be learnt from an examination of Fig. 1, which is a diagram showing the total receipts and the total expenditure of production, distribution, sale, &c. These, the running expenses, do not include interest on borrowed capital and sinking fund for the repayment of the capital, as required by the Local Government Board in the case of corporations.

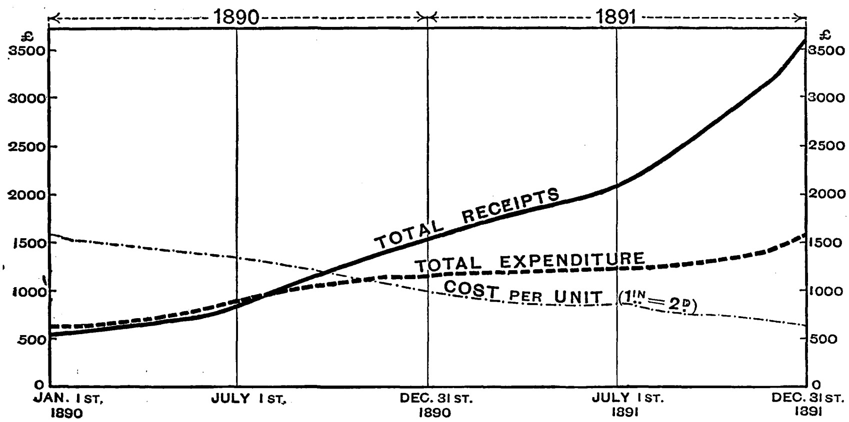


Fig. 1

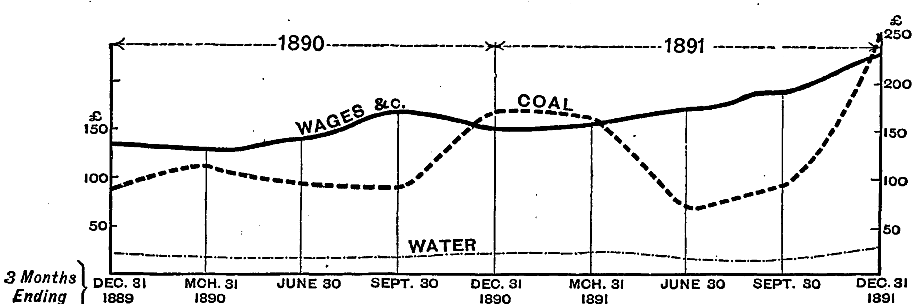


Fig. 2

The Table of the Profit and Loss account for 1890 and for 1891, which gives in detail the various items referred to in Fig. 1 is on p. 638. Also the Tables of the Capital Expenditure, and of the Net Revenue account for the same period.

An inspection of the wages, coal, and water consumption diagram (Fig. 2), as well as the rate of production per unit (excluding interest and sinking fund) will show in what a small ratio these items have increased; in proportion to the augmentation, both in the electrical output and in the receipts.

This is due, partly, to the fact that the services of the staff have been better utilised, latterly, than was possible at the commencement. To this result the use of the secondary battery has contributed largely; by allowing the services of the staff to be confined to twelve hours, on an average, mostly during the day

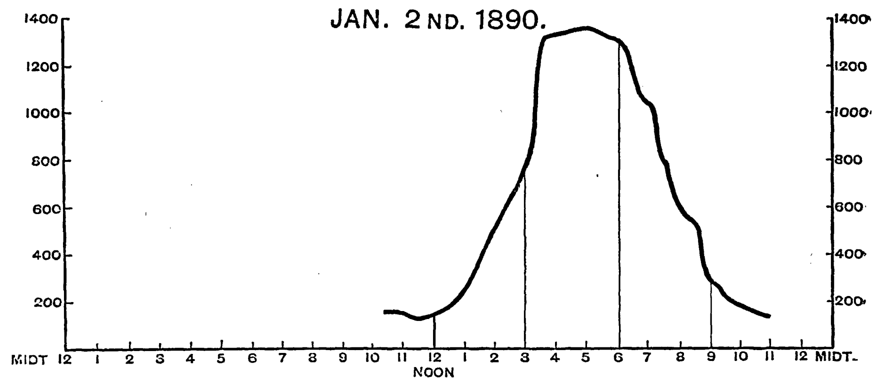


Fig. 3

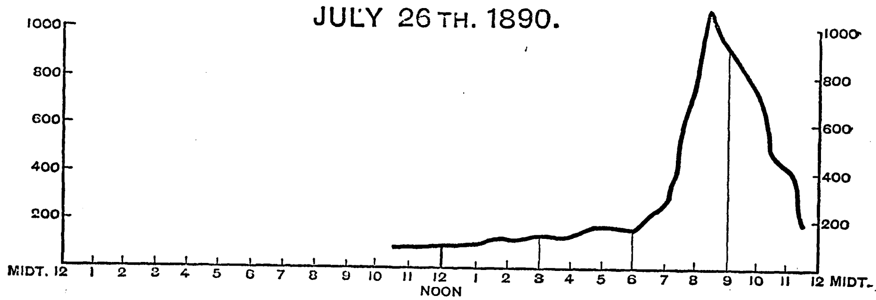


Fig. 4

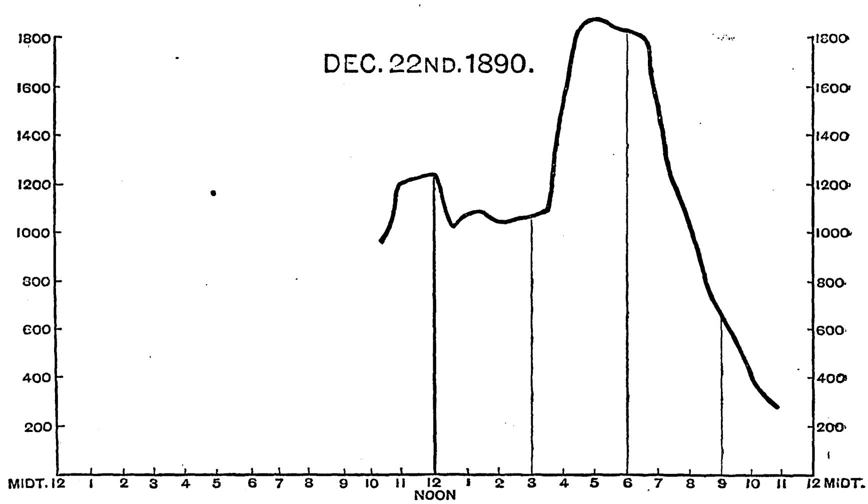
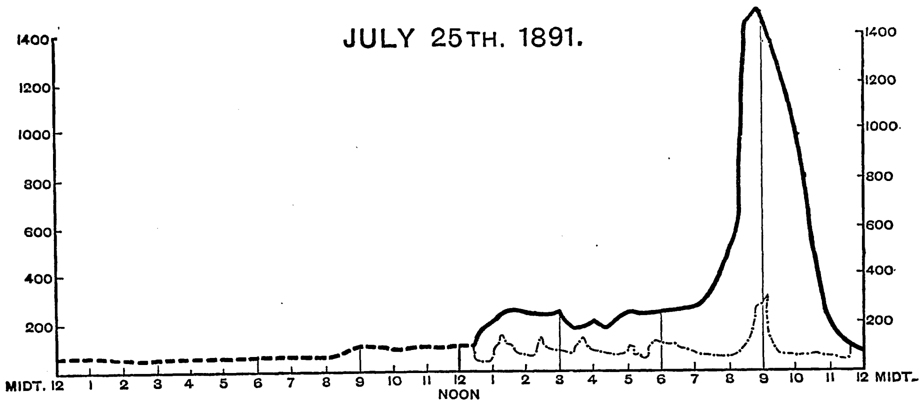
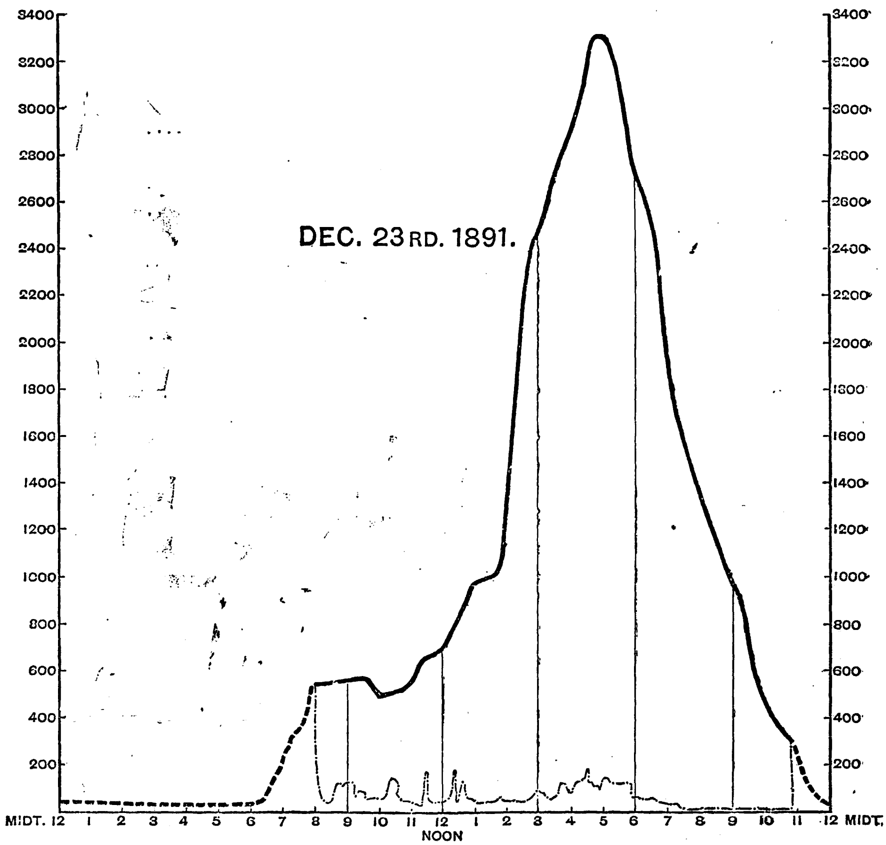


Fig. 5



JULY 25TH. 1891.
1400
1200
1000
800
600
400
200
MIDT. 12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
1
2
3
4
5
6
7
8
9
10
11
12 MIDT.

Fig.6



DEC. 23RD. 1891.
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
MIDT. 12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
1
2
3
4
5
6
7
8
9
10
11
12 MIDT.

Fig.7

PROFIT AND LOSS ACCOUNT—1890 AND 1891.

EXPENDITURE.	Six Months ending June 30, 1890.	Six Months ending Dec. 31, 1890.	Six Months ending June 30, 1891.	Six Months ending Dec. 31, 1891.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Salary and wages	367 16 8	410 17 10	418 14 3	506 19 0
Coal	246 17 11	247 0 6	292 18 6	341 15 0
Water	33 16 4	34 0 0	34 15 6	36 19 0
Repairs and miscellaneous	100 11 5	204 13 3	266 8 9	431 10 0
Rent of land	83 18 2	83 18 1	83 18 1	83 18 1
Rates and taxes	46 0 0	104 6 6	67 1 8	69 11 6
Bank interest and commissions	19 1 4	89 14 9	95 9 7	120 7 5
Total expenses	898 1 10	1,174 10 11	1,261 5 4	1,591 0 0
Cost per unit sold	5·51d.	4·10d.	3·56d.	2·47d.
Total receipts	858 14 10	1,552 9 9	2,093 13 6	3,592 1 0
Units sold	39,113	68,794	85,103	154,258

CAPITAL EXPENDITURE ACCOUNT.

	£	s.	d.
1889.			
To Dec. 31	18,456	2	4
1890.			
,, June 30	25,223	19	11
,, Dec. 31	27,668	9	0
1891.			
,, June 30	35,370	7	11
,, Dec. 31	40,224	19	10

NETT REVENUE ACCOUNT.

	£	s.	d.	
1889.				
Dec. 31, debit	1,079	8	5	Net loss
1890.				
June 30, to loss on half-year	732	6	11	Net loss
Dec. 31 do. do.	315	6	0	Net loss
1891.				
June 30 do. do.	30	5	4	Net loss
	2,157	6	8	
Dec. 31. By profit on half-year.	971	4	10	Net profit
	£1,186	1	10	

hours, instead of being scattered over the entire twenty-four (as would be the case with an "alternating" current station).

Again, as regards coal and water. Both of these items, the former more especially, have been much reduced of late by the use of the Feed-Water heater, and of the Fuel Economiser; these taking advantage of the heat (which would otherwise have been thrown away) contained in the waste steam, and in the smoke, after it has passed away from the boilers.

The economical value of each of these apparatus may be estimated from the following facts:—The average temperature of the feed-water to the boiler was when taken from the town supply, 55° Fahr.; this after passing through the feed-water heater was raised to 180°; and this again when passed through the fuel economiser, was raised to 280° before it entered the boilers.

By the word "coal" it must not be supposed that anything approaching to "picked steam-coal" is meant. The best of the coal used at Bradford would be well described by the word "nuts;" and to this is added, at the boiler, a very large proportion of "slack," or coal-dust of a poor description, and also of coke, of late. The best coal above used, the "nuts," costing from 8s. to 10s. per ton, according to the market value; while the "slack" costs about half that price.

It will be readily seen that engine trials,

intended to show a consumption of one and a half pounds of coal per indicated horse-power per hour, are not made with the above sort of stuff.

It should also be borne in mind that the figures given in the table are those of the "gross" coal bills, which include all the fuel required to keep the fires "banked" (during twelve out of the twenty-four hours), as well as all waste, and also engine trials, &c.

While on the question of coal, it may be urged that Bradford, and many other places in the vicinity of coal-fields, are in a better position than other towns which are situated farther away from those fields.

It may be of some interest to consider, what effect this difference in the cost of coal has upon the expenses, and consequently upon the selling price of the electrical energy, at each of such installations. For it may be assumed that the other matters, such as wages, water, oil, &c., remain pretty nearly the same in all large towns.

The author has had brought under his notice several places where these differences occur; in some cases engine coal costing about 25s. per ton, or about three times what it does in Bradford. After a careful consideration of such cases, the extra cost in the supply of coal would appear to be met, generally, by the increase of one penny per unit in the selling price.

This rough estimate is, moreover, borne out in the case of gas (the manufacture of which is affected in almost precisely the same way). It will be found that the price of gas per thousand cube feet, under similar circumstances, is increased by from 10d. to 1s., or a little over; and, taking roughly the illuminating power for domestic purposes of the electric unit as that of one hundred cubic feet of gas, this increase would correspond to the above rate.

In respect of water, however, the town of Bradford has a distinct advantage over many other places.

The Corporation supply (which alone is used at these works) is drawn from catchment mountain-basins, situate on a millstone-grit formation. It is of a peaty character, with a hardness of from two to four degrees, and it is admirably suited for use in boilers. It does not, of course, need the use of a "Water-softener," or of any other expedient, chemical or mechanical, to get rid of the excessive degree of hardness, or of other of the impurities which prove so detrimental to the well-being, as well as to the duration of boilers.

In conclusion, I have to request the Members of the Society of Arts (a Society which so faithfully and so thoroughly carries out its title as "The Society for the encouragement of arts, manufactures, and commerce") to join me in thanking

First, the Corporation of Bradford, not merely for their disinterested action in being the first to take up, and solve satisfactorily the question of the public supply of electricity by the local authority, but also for the way in which they have unstintingly and without reserve placed the results of their experience at the disposal of other Municipal Authorities, who may be desirous of carrying out, to the best of their ability, and for the benefit of their respective ratepayers, their duties, as regards a public supply of electricity.

Next, amongst the various members and officials of the Corporation, I must particularly refer to the Chairman of the Gas and Electricity Committee, Alderman Priestman, J.P., and to the worthy and much-respected Town Clerk, Mr. W. T. McGowen. Since it is not too much to say that, had it not been for the foresight and business qualities of those two gentlemen, coupled with their firmness and tact, in dealing with the many difficulties which, naturally, beset a young and novel undertaking of this kind, it is extremely doubtful whether there would have been any public supply of electricity in Bradford at all, even at the present time. To myself, personally, their kindly support and assistance, ever readily placed at my disposal, has been evinced on so many occasions, that I am unable, adequately, to do anything more than simply thank them.

I must also advert to Mr. S. W. Baynes, the present resident manager of the installation, and to the ready co-operation which he has always afforded me, not merely in his present position, but also previously, while acting as clerk of the works during the construction of the works described in the paper. To his indefatigable energy, and good management in the working of the installation, is due, very largely, the commercial success which has attended it.

My thanks are also due to the several contractors who have been connected with me in carrying out the works. But, as by far the largest part of those works, as well as the heaviest responsibility, fell to Messrs. Siemens Bros. & Co., so must I also mention Mr. A. Siemens, of that firm, and his hearty co-operation and assistance ·er afforded when-

ever any peculiar or novel question presented itself for solution.

To my various brother officials of the Corporation of Bradford, as well as to others outside thereof, I would give my best thanks for the kindness and courtesy which I have received at their hands.

DISCUSSION.

The CHAIRMAN said there was one omission in the paper which he wished Mr. Shoolbred would supply, viz:—the number of lamps fixed.

Mr. SCHOOLBRED said he always objected to put the information in that form, which he considered most delusive. The number of lamps fixed did not tell you the number burned, any more than the number of gas-burners told how much gas was consumed; 3,500 ampères was the maximum output, and if 16-candle lamps were used there would be probably about 7,200 burning at one time. How many were fixed he could not say — perhaps double that number, but the Corporation had no power to enter the houses and see what the fittings were. The lamps were of all kinds from 8-candles upwards, and there were some arc lamps. Possibly Mr. Baynes might have some data on the subject.

Mr. BAYNES said there were at present 19,000 lamps on the circuit, all reckoned as 8-candle-power lamps; and the arc lamps were counted in the same way.

Mr. R. E. CROMPTON said he was much pleased to find that what he had so long strenuously advocated—the use of accumulators, coupled in parallel with a number of steam dynamos of various styles—had proved so successful in this case, and that in such a crucial test as that shown in the last diagram, where the largest engine was suddenly thrown out of use, the accumulators had prevented a breakdown. Several similar instances had occurred in London, one in particular where the safety-valves of the boiler lifted, and the boiler was rendered useless for a considerable time. In that case there was a much greater drop in the E.M.F. than was shown in the diagram, but still the supply was maintained. In several large stations where accumulators were used there had been no interruption of the supply for several years. He was also glad to have Mr. Shoolbred's testimony to the fact that this method was not excessively costly, but on the contrary, economical. The diagrams showed very clearly what a fluctuating load was thrown on the engine, and what a different task the electric lighting engineer had to perform to that of driving ordinary machinery in a factory, or in a steamship. They were often told that accumulators were not economical, and it was only since he read a paper last year at the Institution of Engneers that people began to recognise the conditions under which they worked, and how widely they differed from those to which they had been compared. Though many engineers to private companies had volunteered similar information their testimony was often looked on with suspicion, but this was so entirely impartial and unbiassed that it would be of great use in combatting the absurd pretentions sometimes brought forward by the advocates of special systems. Mr. Shoolbred would add greatly to the value of his paper if he could give more detailed information as to the comparative efficiency of his boilers. In London, on account of the restricted space, they generally used other systems, and were often told that economy could be effected by the use of Lancashire boilers, and he should be glad to know, therefore, what the evaporative power actually was per heat unit. He did not think Mr. Shoolbred had done much better with his boilers than they did in London, allowing for the difference in the cost of fuel.

Mr. ALEXANDER SIEMENS, after thanking Mr. Shoolbred for the kind way in which he had spoken of his firm, said he could not agree with him as to the use of accumulators. The diagram showed that when a sudden stoppage occurred the battery-power was of great use, which he did not deny, but he thought batteries would only be useful in what might be called toy stations. If the demand required the addition of a battery giving 500 ampères, it only showed that the station was not big enough. If the same sort of thing occurred in a full-sized station, there would be a larger number of dynamos, and when one failed the others would take up the work, without causing even the trifling drop in the potential as had taken place there. He was very glad to see this success of a station worked by a local authority, because he thought gas, water, electric light and such things could be best supplied to the consumers by public authorities, so that any profit derived should go to the whole community. The diagram showed how quickly such an undertaking might be rendered profitable. The shape of the curves was startling enough, but it simply showed that, so far, there had been merely a lighting business done: the curve would flatten out when motors came more into use. There was another mode of overcoming the difficulty of a varying load, but, as it was about to be patented, he would say nothing about it, except that he thought it would astonish the accumulator people.

Mr. WILLANS congratulated Mr. Shoolbred and the Corporation of Bradford on the steady progress made since the commencement. It was very satisfactory to him to find that the first corporation to take up the subject had recognised the importance of adopting direct driving, especially as it was a town where all the machinery was driven by belts or ropes from large engines revolving slowly. Millowners and people accustomed to machinery hardly understood the conditions which obtained in a central electric light station. Last week he had occasion

to start a cotton mill engine of about 659h.p., and it was really child's play to what an electric light engineer had to do, it was so simple in comparison. If this station had been fitted upon the mill plan, they would have put up a 500 or 600h.p. engine, and if anything had happened to it all the lights would have gone out, unless accumulators were employed, and even they could not have carried on the whole thing; and the engine for a great part of its time would have been doing hardly anything in proportion to the coal it consumed. It was only by dividing the total power required into units of reasonable size, that economy could be effected. Even then the time during which the engines were at work was so short, that they could never hope to compete in economy with engines driving steamships or factory machinery.

Mr. BAILEY regretted the absence of any information as to the number of lamps connected, or the average time they burned during the year; and in order to give that, it would be necessary to analyse the use of each lamp. Nothing would be more useful than to know what was the most remunerative class of customer. It was clear from the diagram that if 3,200 ampéres went out on a certain day that would represent about 9,600 8 candle power lamps, and therefore if there were 9,000 lamps connected, the lamp factor was about 50 per cent. If that were so he congratulated the Corporation of Bradford on a result which was rarely attained, the average in London for house and shop lighting being 33 per cent. This point had several bearings, it might bring down the revenue per lamp, but on the other hand, it introduced a term which might be rather dangerous on very dark or foggy days when a greater proportion of lamps might be on. The whole object of keeping a strict record of lamp connections was to look out for that danger signal, and not go beyond the point where it was safe to connect more lamps without increasing the plant. It would always be very useful if a map of the district could be added to the paper. It was desirable that a corporation undertaking the supply of electricity should treat all ratepayers on the same footing. It was clear the whole town could not be supplied from this station, and therefore he should like to know, not only the number of lamps connected per yard run, but what area was left unsupplied by the existing plant, and if it would be possible, by increasing the present plant, as arranged, to supply the whole of those who might be expected to require the electric light.

Mr. RECKENZAUN asked for details as to the cost of installation, engines, boilers, dynamos, &c.

Mr. BAYNES was happy to be able to endorse all that Mr. Shoolbred had said concerning the Town Clerk and Chairman. In response to Mr. Crompton's inquiries, he might say that Mr. Shoolbred had rather over than underestimated the cost of coal; the average cost being rather over 6s., including a large amount of slack. The water evaporated was 6·684 lbs. per lb. of coal at a working pressure of 140 lbs., or reduced for feed water at 212° F., and evaporation at atmosphere pressure, 7·59. The coal was of very low calorific value, but, at the price paid, was probably cheaper than Welsh coal. The lamp hours could be arrived at from the following figures: 20 units were consumed per annum for a 35 Watt lamp, and the apparent revenue was 9s. 7d., taking the average cost of electricity at 5½d. per unit. The total leakage between the mains was ·02 ampères=500 ohms insulation resistance, including mains, switch boards, dynamos, and a large number of the lamps on the circuit.

Mr. MCGOWEN (Town Clerk of Bradford) said he did not pretend to any intimate acquaintance with the scientific side of the question, but he thought it was a bold venture on the part of the Corporation to go into the matter in the way they did. They had every confidence in the skill and ability of Mr. Shoolbred, but still it was thought necessary on all the most important points to obtain the advice of the highest authorities, and, though there were some differences of opinion, in the end, he believed, even those who held the strongest views in opposition to the methods proposed and carried out had been convinced that they were the right ones. It was very satisfactory to him to find such a general consensus of opinion, by gentlemen competent to speak, in favour of the means adopted for carrying out this work. One point which led to considerable controversy was the size and character of the engines to be employed—whether they should have one or two of enormous power, or a larger number of moderate size, which could be used as occasion required; and it would be very gratifying to the Corporation to learn that the course adopted had been approved.

Sir THOMAS BAZLEY, Bart., asked if the accumulators stood their work well, or required much repair.

MR. GARCKE said the accounts of local authorities were sometimes looked on with suspicion because it was supposed that any particular department might be favoured to some extent at the expense of another if so desired, and with a view to disarming that kind of criticism it would be well if further details could be given of the profit and loss account. The only item of standing charges was wages and salaries £506 for the half-year, which was a very low figure; he did not see any items for rent of offices, clerks, insurance, collection, bad debts, or any other items of that description. The total came out very low, and if there were any other matters which ought to be charged they would not prejudicially affect the result. The chief lesson to be learned from the paper was that local authorities could establish and work these stations very economically, and to the advantage of everybody. This point had already been mentioned, but deserved emphasizing, especially as the cost per lamp was very low, and compared

favourably with central stations established by private companies. The cost of coal was low for the special reasons referred to, but all the other expenses also were very low. If Mr. Shoolbred could conveniently tell them the total number of units generated it would afford, in comparison with the units sold, a very clear view of the efficiency of the system.

Mr. ALBRIGHT asked if the 2·47d. per unit included the cost of distribution as well as the engineering expenses, and if the depreciation of the mains was included in "repairs and miscellaneous." That had an important bearing on the question raised by Mr. Bailey as to the size and nature of the district. He feared some people would take up these figures, and jump to the conclusion that the difference between the 2.47d. and the price at which it was supplied was all clear profit. Mr. Baynes said the average earning per lamp was 9s. 7d., and the total number of lamps fixed 19,000; but if the total revenue were divided by 9s. 7d., it gave about 7,000 lamps fixed. Of course, the number of lamps might have been doubled or more since that account was prepared.

Mr. BAYNES said that was the explanation. There were 19,000 lamps now, reckoning the present applications for lights, &c., but at the date when the balance-sheet was made out they were much fewer.

Mr. OLIVER WILLIAMS asked for further information as to the probable deterioration of the plant and the mains, and particularly in the batteries.

Mr. SHOOLBRED, in reply, said it was very difficult to give exact details as to the evaporative power of boilers, when they were once started in regular work. Several trials were made in early days as to the quantity of coal consumed and water evaporated, but when once the station was fairly in work, it was almost impossible to go on with such inquiries. He thought it very doubtful whether the Babcock and Wilcox boiler, taking it all round, came up to the Lancashire, though, in certain circumstances where steam was suddenly required, it might be more convenient. With reference to the remarks of Mr. Bailey and others about lamps, he would point out that there was a material difference between the position of a corporation and that of a company; a corporation had nothing to do with the lamps inside the houses, and did not know what they cost or how long they lasted; whereas companies frequently derived a considerable income from lamps and fittings. The number of lamps was a delusive mode of gauging the output of a station, which should be reckoned in ampères, at a certain pressure. With regard to the invidious distinction involved in selecting a certain portion of the town, some complaints were made about it in early days, but the ratepayers' fears and jealousies were allayed when it was found that the compulsory area was selected by the Board of Trade in the first instance, and the question of extension was entirely in the hands of the ratepayers themselves. When a sufficient number came forward and asked for a supply to guarantee a certain revenue, the corporation could make the extension by a resolution of their own body. They had to begin somewhere, and in order to do it at all under commercial conditions, a small number of streets were selected by the Board of Trade, so as to relieve the local authority of the onus of such selection. He had no hesitation in saying that this system of low pressure selected could be carried out, not only throughout the town of Bradford, which was, roughly speaking, an oval about five miles by three miles in extent. But it might be readily extended to other districts in the vicinity. For, he thought, the Corporation intended supplying neighbouring districts, though outside the borough, with electricity in the same way as they did with water. Of course there would have to be proper intermediary stations, which would be gradually increased. There would be no necessity for introducing what was termed high pressure. In some of the feeding mains it might be necessary to go beyond the 300 volts, which was the nominal limit of low pressure, but not to anything like 2,000 volts, which was ordinarily used with the alternating current system. The question Mr. Reckenzaun asked was, to a certain extent, answered in the paper, and he could not, from memory, give the full details. The total cost of the first installation was £18,456, which included engines of 450 horse-power and dynamos and street distributing service, to correspond; but at that time there were no batteries. They cost, when finished, with their connections, about £2,000; and it was about the best investment that had been made, the saving thereby effected being very great. With regard to their working and maintenance, it was very satisfactory so far; he heard very little ot buckled plates or sulphating; but that was no doubt largely due to careful management. It could be seen by the diagrams that they were charged gradually and regularly, and discharged in the same way; and that really conduced to keeping them clean and in good order; the cost of maintenance was, in fact, a mere trifle. The figures given in the Table included production, distribution, cost of sale, &c; there were no clerks or collectors to charge for as extra. Possibly a few items might come in under the head of "miscellaneous;" but every thing connected with the business was included in the Table. Later on, a larger staff might be required for collection, but that would be similarly included. A careful distinction was made between expenditure on capital account—such as laying down new mains—and what was fairly charged to revenue. But he should point out, as was distinctly stated in the paper that these running expenses did not include interes on capital, or sinking fund for its redemption, which formed a large proportion of the expenses which a corporation was bound to meet; and, of course, the

proportion of these expenses was to be added to the cost of the 2 47d. per unit (the cost of production in the latter part of 1891), as named in the Table. He was glad to find that the mode of dealing with the question of the engines to be employed had met with approval. It was of course desirable that these engines should be worked, as far as possible, under the most favourable conditions, which meant under as near a full load as possible; and that could only be attained by having several sizes of steam-engines, which should correspond somewhat to the variation in the daily demands of the different seasons of the year.

The CHAIRMAN, in proposing a vote of thanks to Mr. Shoolbred, said he felt very strongly that the Coporation who failed to introduce the electric light to their ratepayers were neglecting a very serious duty. Not only on economical but on sanitary grounds they ought to take up the matter, and this paper showed very forcibly that financial success would attend the operation. Bradford was the first Corporation which had had the temerity to attack this question, and they were all delighted to find that their courage had met with its reward. He had been surprised at the hesitation shown by Mr. Shoolbred in answering the question he put as to the number of lamps, which was the very pith of the whole question. In regulating domestic expenditure or establishing a business you required to know how many mouths you had to feed or what demand you had to meet, and if you wanted to supply electricity you wanted to know how many lamps you would have to supply with current. When you knew how many lamps were to be fixed all the rest followed as matter of course. Experience showed that only a certain percentage of those fixed required to be supplied with current at the same time, and when you knew the current you knew the power required, and from this could calculate the engines, dynamos, and plant necessary at the central station. Another reason for asking the question was because he wanted to have some conception how far electricity was interfering with gas in Bradford. He was interested in this as a gas shareholder, but up to the present moment he had never felt any anxiety about his gas property. Electricity was not interfering with gas in any way, and he did not think it was likely to do so. The users of gas wanted to know what was the comparative cost of electric light. The average price of gas in England was about 3s. per thousand feet, and the average cost of a gas lamp was 9s. per annum. If at Bradford the average price paid per electric lamp was 9s. 7d. it showed there was not much difference between the cost of electricity and gas, and they could tell people with confidence that the cost would not be much more. But when a man introduced electric lighting he generally had gas fixtures, pipes and so forth, and he began to think how he could make use of them and apply the gas to other purposes, and so he applied it to heating, cooking, and power. Wherever electric lighting was introduced it not only did not diminish the supply of gas, but increased it. He must also enter his protest against the question of the relative advantages of continuous and alternating current being disposed of so summarily as was done in this paper, and the same with regard to high pressure and low pressure. Engineers were called upon to apply this great force of nature, and to do it in such a way as to incur the least possible expenditure both of capital and revenue. When an engineer went to a particular district he had to take everything into consideration, and if he found he could more cheaply apply continuous currents he would do so, but if he found the alternating current was more advantageous he would use that. He was using much more the continuous current than the alternating on account of the special circumstances. There were two central stations in London connected with the Post-office, each as large as that of Bradford, one in the City, supplying sufficient current for 10,000 lamps, the other, nearly completed, and of the same size, at Mount-pleasant. In each of those localities they had to supply a small compact district; but when they went to large scattered districts like Manchester, Bristol or Liverpool, he could not conceive any one introducing anything else but a good, well worked out high pressure system. Mr. Shoolbred had said that the alternating current could not be utilised for supplying motive-power, or for electrical deposition or storage; but though this might have been true once it was not true now. The great lesson they learned at the Frankfort Exhibition was that alternating currents were more economical for motive-power than continuous, and you could charge batteries and deposit metals equally well with such currents; it only required the introduction of a transformer to convert the alternating current into a continuous form. One other question was that of using secondary batteries as a stand by to provide against a breakdown. No one in a toy station, as Mr. Siemens called it, would dream of constructing his installation without putting in a battery, but it was simply a question of £ s. d. Mr. Shoolbred had shown that the one he used was equivalent to an additional 50 horse-power engine. On the one hand must be put the depreciation in the battery, the attendance required to keep it in order, and so on; and on the other, the cost of maintaining and working a 50 horse-power engine. If they were about equal, well and good. You must choose whichever was most convenient, but you would come to a point sooner or later where the cost of maintaining a small engine and dynamo would be much less than that of maintaining the battery, and then the battery must go, and the engine would have to do the work. They were much indebted, not only to Mr. Shoolbred, but to the authorities of Bradford for having so cheerfully, not only shown the details of their central station to all who were interested, but for giving and allowing their consulting

engineer to give so much detailed information. The pluck and liberality shown by the Corporation had done more probably to assist the progress of electric lighting than anything else could have done, and he must therefore ask the meeting to include the Corporation of Bradford in the vote of thanks.

The vote of thanks was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

MAY 11.—G. L. ADDENBROOKE, "Uses and Applications of Aluminium."

MAY 18.—Captain W. de W. ABNEY, C.B., F.R.S., "Colour Blindness." R. BRUDENELL CARTER, F.R.C.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

MAY 19. — JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Indian Census of 1891." Sir CHARLES BERNARD, K.C.S.I., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MAY 17.—WILLIAM SIMPSON, R.I., "Mud as a Material for Architecture in Persia and the East." General ROBERT MACLAGAN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

Professor PERCY F. FRANKLAND, Ph.D., B.Sc., F.R.S., "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." Four Lectures.

LECTURE II.—MAY 9.—Culture media—Methods of sterilisation—Pure cultivation—Special methods for the cultivation of particular micro-organisms.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 9... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Percy F. Frankland, "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." (Lecture II.)
North-East Coast Institute of Engineers and Shipbuilders, 8, Nicholas-buildings, Newcastle-on-Tyne, 7½ p.m.
Surveyors, 12, Great George-street, S.W., 8 p.m. Professor G. E. S. Boulger, "The Scientific Study of Timber."
Geographical, University of London, Burlington-gardens, W., 8½ p.m.

TUESDAY, MAY 10...Society of Architects, St. James's-hall, Piccadilly, W., 8 p.m. Rev. J. E. Field, "Monumental Brasses."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. E. Ives, "Photography in the Colours of Nature." (Lecture I.)
Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.
Civil Engineers, 25, Great George street, S.W., 8 p.m. Mr. A. P. Trotter, "The Distribution and Measurement of Illumination."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m. Mrs. Bishop (Miss Bird), "The Ainos of Japan."
Colonial Institute, Whitehall Rooms, Northumberland-avenue, W.C., 8 p.m.

WEDNESDAY, MAY 11... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. G. L. Addenbrooke, "Uses and Applications of Aluminium."
Geological, Burlington-house, W., 8 p.m. 1. Prof. T. G. Bonney, "The so-called Gneiss of Carboniferous Age at Guttannen (Canton Berne, Switzerland)." 2. Prof. Grenville and Messrs. A. J. Cole and G. W. Butler, "The Lithophyses in the Obsidian of the Rocche Rosse Lipari."
United Service Institution, Whitehall-yard, S.W., 3 p.m. Mr. W. Laird Clowes, "The Place and Use of Torpedo Boats in War."
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, MAY 12...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 8½ p.m. Third Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, W.
Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Chemistry of Gases." (Lecture III.)
Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. A. P. Trotter's paper, "Notes on the Light of the Electric Arc." 2. Dr. J. H. Gladstone, "The Cause of the Changes of Electro-motive Force in Secondary Batteries."
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 13...United Service Club, Whitehall-yard, S.W., 3 p.m. Captain J. D. Fullerton, "Modern Aërial Navigation."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. W. Huggins, "The New Star in Auriga."
Institute of Architecture, Science and Art, Dundee, 8 p.m.
Astronomical, Burlington-house, W., 8 p.m.
Philological, University College, W.C., 8 p.m.
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. Richard Inwards, "An Instrument for drawing Parabolas." 2. Mr. F. H. Nalder, "Some Electrical Instruments." 3. Messrs. E. Edser and H. Stansfield, "An Instrument for measuring Magnetic Fields."

SATURDAY, MAY 14...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. Dannreuther, "J. S. Bach's Chamber Music" (with illustrations). (Lecture III.)
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, MAY 13, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

GENERAL MEETING.

Temporary Alteration of Bye-laws.

The Council hereby convene a General Meeting of the members to be held at the Society's House, in the Adelphi, on Wednesday, the 18th May, 1892, at 4 o'clock in the afternoon, for the purpose of considering, and if thought desirable of passing, the following resolutions:—

1. That in accordance with the proposal from the Council, the Bye-laws be altered and varied in such manner that the Council shall be empowered, during the years 1892 and 1893, to appoint not more than six members to be Vice-Presidents or other Members of the Council in addition to those appointed under Bye-laws 79 and 84, and that the Council be empowered to determine the period or respective periods that members so appointed shall continue in office, not being later than the end of the Session commencing 1893, and that all Bye-laws which are inconsistent with such appointment and determination be suspended or varied.
2. That Bye-laws 8, 9, and 10 be suspended during the Sessions 1892-3 and 1893-4.

By Order of the Council,

Henry Trueman Wood,
Secretary.

2nd May, 1892.

Bye-Laws 8, 9, *and* 10.

8. The Chairman of the Council shall be chosen from those Members of the Council who are of one year's standing at least.

9. The Chairman of the Council, after two years' service, shall not be re-eligible to the office for at least one year.

10. The Chairman of the Council shall deliver an address to the Society at its Ordinary Meeting after his election.

CANTOR LECTURES.

The second lecture of the course on "Recent Bacteriological and Chemical Research in connection with the Fermentative Industries," was delivered by Professor Percy F. Frankland, Ph.D., F.R.S., on Monday evening, 9th inst.

The lectures will be published in the *Journal* during the autumn recess.

Chicago Exhibition, 1893.

INDIA COMMITTEE.

A meeting of the India Committee was held on Tuesday, 10th inst. Present: Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E. (Chairman of the Committee), Sir Frank Forbes Adam, C.I.E., Lionel Robert Ashburner, C.S.I., M. M. Bhownaggree, C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M D., C. Purdon Clarke, C.I.E., William Digby, C.I.E., Sir Joseph Fayrer, K.C.S.I., M.D., LL.D., F.R.S., Colonel C. L. O. Fitzgerald, C.B., W. S. Halsey, Lieut.-General J. Michael, C.S.I., Dadabhai Naoroji, Charles Pontifex, Vincent J. Robinson, C.I.E., Alexander Rogers, Thomas H. Thornton, C.S.I., D.C.L., Stephen Wheeler, Sir Alexander Wilson, Sir Henry Trueman Wood, M.A., Secretary of the Royal Commission, and S. Digby, Secretary to the Committee.

AMERICAN PATENTS.

The following Act has been passed by the United States Congress:—

"An Act to protect foreign exhibitors at the World's Columbian Exposition from prosecution for exhibiting wares protected by American Patents and Trade marks."

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled.* That no citizen of any other country shall be held liable for the infringement of any patent granted by the United States, or of any trade-mark or label registered in the United States,

where the Act complained of is or shall be performed in connection with the exhibition of any article or thing at the World's Columbian Exposition at Chicago.—Approved April 6, 1892."

APPLICATIONS FOR SPACE.

Intending exhibitors are reminded that applications can only be received up to Saturday, 21st May. Any applications received after that date will be filed, in case of any space becoming hereafter available, but will not be included in the allotment.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 28, 1892; SAMUEL SMITH, M.P., in the chair.

The paper read was—

THE REORGANISATION OF AGRICULTURAL CREDIT IN INDIA.

By SIR WILLIAM WEDDERBURN, BART.

In India, the one great industry is agriculture. There are very few large towns. And of the 222,000,000 of British subjects some 80 per cent. are more or less directly dependent upon agriculture; the backbone of this great agricultural class being the ryots, or peasant cultivators, who, throughout the whole peninsula, live grouped together in village communities, somewhat similar to English rural parishes. Such being the nature of the population, the most vital of Indian questions is the condition of the Indian ryot. Upon his ability to pay taxes depends the financial stability of the empire, and upon his contentment depends its political safety. If, therefore, we regard our Indian empire from a selfish point of view, the ryot comes first in importance. Also he comes first from the point of view of our responsibility and duty. For if there is death and disaster in India from war, pestilence, or famine, the ryot is the principal sufferer. And in his sufferings he has no one to look to but us. We retain all the power in our own hands; and therefore upon us rests the whole burden of the responsibility.

I repeat, the most vital question in India is the condition of the India ryot. And unfortunately his condition, for the most part, is very bad. He and his family subsist with difficulty upon the poorest and most scanty fare. A well-known official estimate has declared that one-fifth of the population, that is some 40,000,000 of persons, are chronicly in a state of semi-starvation, passing through life without ever having their hunger satisfied. Possessing no savings of money or food, and living thus on the verge of subsistence, the Indian peasantry are therefore helpless in times of scarcity. And one bad season, one failure of the periodical rains, is sufficient to produce widespread famine, and to cause the death of hundreds of thousands, and even millions, of these unfortunate people. In the last great famine in Madras and Bombay 5,000,000 of persons were officially reported to have died of starvation: that is, a mass of human beings exceeding the whole population of Ireland, mostly frugal industrious peasants, men, women and children, for whose welfare we are directly responsible, perished within the space of little more than a year from the slow pangs of hunger.

Now my object in addressing you to-day is to say that I am firmly convinced that this suffering is altogether unnecessary and preventible. These wholesale disasters are simply and solely due to the extreme and chronic poverty of the people. Famine would practically be prevented if the ryot were in a position to tide over even one bad season. And there is no reason whatever why, with his industry, thrift, and skill, he should not attain that position. The ryot's difficulty is a financial one. Give him but reasonable fair play in that respect, and he would make himself not only safe from famine, but comfortable and even prosperous. The poet speaks of the "Wealth of Ind." The phrase seems a mockery looking to the present condition of the country. But none the less India possesses the conditions of almost boundless agricultural wealth. In her vast domain she has climates suited to every known product. She has a fertile soil and an unfailing sun, with abundant labour, skilful and cheap. All that is wanted is capital. Give the ryot that, so that he may be able to command a proper supply of water and manure, and he will produce in perfection every valuable crop known to cultivation. At present the ryot, as a

class, has no capital. He has less than none. For he is deeply, and often hopelessly, in debt. Through this burden of debt his independence and enterprise have been crushed, and he has become the bond-slave of the village money-lender. What the ryot wants is to be delivered from this bondage, and to be supplied with sufficient capital at reasonable rates. He may then be left alone, for he is by nature sturdy and industrious. He will at once proceed to dig a well on his ancestral land, he will supply himself with water and manure, and in the end will turn the whole of India into a garden. I have myself seen such a process going on upon a small scale under my own eyes when, in the neighbourhood of Poona, water and manure were made available. The same land which, when dependent on the natural rainfall, yielded a precarious crop of millet not worth ten shillings an acre, produced, when irrigated and manured, an assured crop of sugar-cane which sold uncut upon the ground for £25 an acre. As I have already said, the ryot's difficulties are of a financial kind. Help him in that matter, and he will do the rest, and soon place himself and his dependents beyond the reach of famine.

It is not as though there were any lack of available capital in the country. From the returns of the three Presidency banks I observe that last year some 14 crores (that is 14,000,000 of tens of rupees) were locked up in those institutions. In Bombay there was such a glut of capital that the Presidency bank had 5 crores of deposits which it did not know how to use, so that it was driven to refuse municipal and other deposits except as current accounts which bear no interest. In the Post-office Savings' Banks at Bombay, some 2 crores were locked up, while private banks could get any amount of deposits at 4 per cent. Such is the plethora of money nigh at hand in India, not to speak of the accumulated capital in Europe seeking investment, while the ryot is perishing for want of it. It is as though on the one hand we had rich but thirsty soil: on the other hand vast stores of fertilising water. What we want is to construct good channels of communication, so that the water may be brought upon the land, to the great benefit of all parties concerned. The question is, how is this to be done? How can agricultural credit be best organised and established on a firm and scientific basis? Fortunately we have for our guidance the example and experience of credit institutions which have been successfully worked elsewhere, especially on the Continent of Europe. There it has been found that agricultural banks have been the salvation of the peasant cultivator. And I propose now to lay before you a brief statement of facts showing the steps taken to adapt the same system to the special needs of the Indian ryot. I will relate the circumstances under which a scheme was formed to establish an experimental bank for this purpose in the Bombay Presidency; and I will show how our project seemed on the eve of success; but how at the last it was defeated and upset. In this matter I have a complaint of a grave kind to make against the authorities of the India-office. The scheme was one which they were bound to support. Nay, more; they ought themselves long ago to have initiated similar measures for the ryots' relief and safety. Yet instead of giving the movement every encouragement, they alone threw obstacles in its way. As I will show presently, all those locally interested welcomed the scheme gladly; public opinion in India and in England was in its favour; the Viceroy in Council strongly recommended the experiment being tried. Everything seemed favourable. All that was needed was the formal sanction of the India-office. This was refused; and the whole scheme was wrecked. To make the facts clear I will divide what I have to say under three headings, showing (1) the position of the ryot and the cause of his financial distress, (2) the nature of the proposed remedy, and (3) the attempt to apply this remedy, and how the attempt was defeated.

(1) *The financial misfortunes of the ryot.*—As our attempt to establish an Agricultural Bank was made in the Dekkhan districts of the Bombay Presidency, and as the Dekkhan ryot is in most respects typical of the peasant cultivator throughout India, I will briefly describe his economic position, showing his customary connection with the village money-lender, and some of the principal causes which have led to his present ruined condition. We shall then see that the ryot's original relations to the money-lender were highly beneficial to both parties; that these relations have become disorganised, mainly through the introduction of unsuitable English laws; and that what is now wanted is to restore the old friendly relations between the parties upon a scientific and well organized basis. In the Dekkhan, then, the old-established connection between the ryot and the village money-lender is the following: the ryot owns the land and

the cattle, and supplies the labour by himself and family. On the other hand the money-lender, who is also a general dealer, maintains the whole party until the harvest becomes available, and provides cash to pay the Government assessment, and for incidental expenses, as when a plough bullock dies, or when a marriage has to be celebrated. He also generally supplies the seed corn. The crop thus obtained is shared between them at harvest time; and this arrangement is fair and equitable, one share of the crop going to the ryot as the reward of his labour, and one share to the money lender as the profit on his capital. There existed thus a sort of *métayer* partnership between them, neither being able to get on without the other. As Sir John Strachey has put it, "Money-lenders are obviously as necessary to the Indian agriculturist as the seed which he sows, or as the rain which falls from heaven to water his fields." In a bad year, if the crop failed, the ryot asked for time to pay his debt: "Have patience with me and I will pay thee all." As in the parable the creditor was then expected to show forbearance, and as a fact he rarely failed to do so. And this natural leniency, arising from the friendly relations of the parties, was increased by the fact that under native Governments, and in the earlier days of British rule, disputes between debtor and creditor were usually disposed of by arbitration, and the creditor had but little legal power to enforce his demands. He had to trust chiefly to persuasion and moral pressure, supported by an appeal to the religious feelings of his debtor. But this easy going arrangement, this friendly partnership between the ryot and the money-lender, was put an end to when, in accordance with English models, the British Government established civil courts in the rural districts, and thus placed a new and very sharp weapon in the hands of the creditor. The power and activity of these courts was gradually increased, and by the Civil Procedure Code of 1859 everything the ryot possessed was made liable to seizure and sale in execution—his house and his land, his plough and oxen, his bedding and his cooking utensils; even his clothing and that of his family was not exempted; and he was further liable to be arrested in default of payment and imprisoned in the debtors' jail. It is easy to understand how completely this change reversed the old order of things. The high rates of interest, 12, 24, and 36 per cent. which were before to a great extent nominal, became now a stern reality. And the creditor, holding in his hand a decree of the court, and attended by its bailiffs, was complete master of the situation. The process of the court became thus a sort of legalised torture by means of which all that the ryot had was squeezed out of him, and he became the mere bond slave of his creditor. The result was an angry antagonism between the two classes, ending in a financial deadlock. On the one hand, the ryot, sunk hopelessly in debt, lost all energy and enterprise; while on the other hand the business of the money-lender was paralysed: he was afraid to make new advances, and unable to recover either the interest or capital of his old loans. The situation and its causes cannot be more forcibly described than in the language of Sir George Wingate, the father of the Bombay Revenue system: "This miserable struggle between the debtor and creditor is," he says, "thoroughly debasing to both. The creditor is made by it a grasping hard-hearted oppressor. The debtor a crouching false-hearted slave. It is disheartening to contemplate, and yet it would be a weakness to conceal the fact, that this antagonism of classes and degradation of the people which is fast spreading over the land, is the work of our laws and our rule."

Such is the unfortunate financial position. The evil is apparent enough. Now let us consider (2) *the nature of the proposed remedy*. We have no heroic remedy to propose. Our objects are of a simple and practical kind. We want to conciliate the classes, to revive good customary village methods, and to restore the old friendly relations between lender and borrower. And these results we hope to obtain by organising a good system of agricultural banks, which are intended not to put aside the village money-lender, but to organise his operations, so that the business may go on smoothly for the benefit of all parties. In this matter we cannot expect much guidance from banking arrangements in England, where the tenure of land is so different from that in India. But, fortunately, in many other European countries we have the example of excellent credit systems specially devised for the benefit of small cultivators whose position is similar to that of the Indian ryot. In all these countries experience has shown that a good system of agricultural banks is absolutely essential for the prosperity of the class of peasant proprietors. It has been found that without such help they cannot maintain their position, and must inevitably

fall into the grasp of the local usurer. Accordingly these banks are universally regarded as State necessities of the first importance. The modern European system originated in Prussia more than a century ago, in the form of mortgage debenture associations, under the guidance of that sagacious monarch, Frederick the Great; and it is in Germany that agricultural banks have received their largest and most varied development, more than 2,000 such institutions being now actively at work with a business amounting to something like £150,000,000 sterling. Among German institutions the "Raiffeisen Agricultural Loan Unions" are specially deserving of notice, being peasants' banks conducted on co-operative principles. Similarly in Austro-Hungary, Italy, France, Belgium, and Switzerland, credit institutions on a large scale have been established for the benefit of the peasant class, private enterprise being the basis of these institutions, while the State gives them every support and encouragement. The Hon. M. G. Ranade, in a valuable paper read last year before the Poona Industrial Conference, gives the latest figures regarding the banks in each of these countries, and points out how liberal are the concessions granted by the respective Governments. For example, the Hungarian Government granted a subsidy of half a million of florins to the reserve fund of the Boden Credit Institute; while it exempts the bank's operations from all stamp duties; lends the help of its officers in assessing the value of property mortgaged; and permits the bank to foreclose or sell the mortgaged and also the unmortgaged property of the debtor, on default being made, without recourse to a court of justice. In France, the Government guarantees the *Credit Foncier* against competition, and lends the assistance of its officers. And similarly in each country direct and active support is given according to local requirements. The result is that an immense business is done at the lowest possible interest, and with the least possible friction and expense. Thus, in France, since 1852, 3,400 millions of francs have been advanced to the landholders through the *Cérdit Foncier*, and the current rate of interest has thus been reduced from 9 or 10 to 5 per cent. In Switzerland, the system is very complete, nearly every canton having its separate mortgage bank. It appears that the Berne Bank has within the last fifteen years been able to reduce its rate of interest from 5 to 4 per cent., the result being that it has nearly trebled the volume of its business. The deposits have increased from about £1,000,000 to over £3,000,000 sterling, and the loans from £1,600,000 to £3,200,000. In the Australian Colonies land credit companies have attained a large development, but I do not lay so much stress upon them because their dealings are for the most part with large land-holders, whereas the European system is suited to small cultivators like the Indian ryot.

As regards methods of working, there are of course differences of detail in different countries. But all these institutions operate chiefly with borrowed capital; and the secret of their financial success consists in this, that they keep down the amount of the shareholders' paid-up capital, upon which a dividend has to be earned, while making their loans out of capital borrowed from the general public at low rates of interest. The bank thus occupies the position of a credit institution between the cultivator, who must have capital to work his land, and the general public who desire a safe investment without the trouble of inquiring into the individual borrower's title or credit. And the profit for these good offices consists in the difference between the two rates of interest. Thus at present the average Indian ryot pays 24 per cent. to the village money-lender. We propose to commence by letting him have the advances he wants at 9 per cent.; and we expect to be able to borrow at less than 5 per cent. Let us see how that would work out as regards the prospects of our experimental bank, operating on the mortgage debenture method. Borrowing at 5 per cent. and lending at 9 per cent. the bank would have a working margin of 4 per cent. on all its operations. If therefore it had a paid-up capital of £100,000, and passed £1,000,000 sterling through its hands, it would realise a gross profit of £40,000 a year, equal to 40 per cent. upon the paid-up capital, an amount sufficient to yield a large profit to the shareholders after providing for all expenses and unfavourable contingencies.

I now come to the last portion of my subject, (3) *our attempt to apply this remedy* in the case of the Indian ryot. In making this attempt our object was to frame a scheme upon the lines of the Continental system, while adapting the details to local circumstances. Especially we had to provide for the settlement of the old debts; we had to restore the friendly relations between the ryots and the village money-lenders; we had to secure for our project the hearty co-operation of

both these classes; and we had to induce the local native capitalists to give our scheme their financial support. Last but not least we had to claim from Government concessions similar to those accorded to such institutions on the continent of Europe. In Europe, as we have seen, it has long been the recognised duty of the State to see that well organised banks are established for the benefit of the peasant class. Private enterprise has been found to be the best basis for such undertakings. But this fact is not held to diminish the responsibility of the State. And when private enterprise is willing to work on the lines approved by Government, the Government gives the banks every possible support, the public credit being utilised to strengthen their financial position, while the machinery of the State is made freely available to facilitate the recovery of their advances. In making our claim for similar concessions on behalf of the India ryot, we felt that in India a similar responsibility rested upon the Government, and in a higher degree than in Europe; because in India Government is the universal landlord, and is therefore more directly responsible, in its administrative capacity, for the welfare of the cultivating class; also as regards legislation, the Government of India retains all the power in its own hands, and is therefore solely responsible for providing the required remedy.

These were the conclusions which formed the basis of the scheme which originated in Poona at the close of 1882. For a considerable time before careful inquiries had been made, and many local meetings held in order to learn the wishes of all parties concerned, and to explain to them the nature of our proposals. At last all was ready. The ryots gladly welcomed the proposal; the village money-lenders were prepared to co-operate; and the native bankers were ready to provide capital. A public meeting was then held at Poona under the presidency of the collector of the district, resolutions were passed for the establishment of an agricultural bank, and an influential committee was appointed. This committee, representing the promoters, waited upon the Governor (Sir James Fergusson) and set forth their proposals, stating that they were willing, upon certain conditions, to establish an agricultural bank for the Purandhar Taluka of the Poona Collectorate, as a private undertaking. They proposed that the capital of the bank should be one crore, the paid-up capital being 20 lakhs of rupees; and the main conditions were that the Government should appoint a Commission to effect a settlement of the old debts within the Taluka, by means of a voluntary liquidation; and that in case of default the advances of the bank should be recoverable by summary process through the revenue authorities, instead of by regular suit in the civil courts. H.E. Sir James Fergusson received the deputation in a very cordial manner, and said that in the Australian Colonies he had had experience of similar institutions which had proved very successful. He expressed himself personally favourable to the scheme, and promised that he and his colleagues would give it their best consideration.

Our proposals reached the Viceroy in Council at a favourable moment. It had always been the policy and wish of the Indian Government, as general landlord, to help the ryot with loans for land improvement. But from various causes the attempts to make these advances through official agency had failed in every part of India. And the Government had at last come to the conclusion that it must look to private enterprise for any real progress in this direction. The Marquis of Ripon was then Viceroy, and Sir Evelyn Baring, who was then Finance Minister, had personal experience of the Egyptian Credit Foncier, so that the Poona scheme received immediate and sympathetic consideration, as providing the exact means desired to carry out the Government policy. And a very important despatch, No. 638 R, of 5th December, 1882, was sent from Simla to the Bombay Government, expressing the satisfaction of the Viceroy in Council with the proposals made, and setting forth in detail the action which the Government were prepared to take. Subject to certain minor conditions, the Government accepted the Poona proposals. They were willing to appoint a Commission for the liquidation of the ryot's debts within a limited experimental area; they would advance, in the first instance, the cash (some 6½ lakhs) necessary for the composition of these debts; they would, as regards the bank, remit a part of the stamp duty on documents and the court fees in suits; and they would concede to the bank the privilege of recovering its advances through the revenue officers as arrears of revenue. While granting these important concessions, the Government of India were careful to explain to the Bombay Government that similar privileges would not necessarily be granted in future to other similar

banks. The Poona Bank was, in fact, treated as a pioneer enterprise; the object being to make a practical experiment in a limited area, with the hope that when the system was once established and found to be workable, it would spread wherever needed, and, to use the words of the despatch, "prove of incalculable benefit to the whole country." In conclusion, the Government of India stated that they attached very great importance to the experiment, and asked the Bombay Government to undertake the working of the measure. In reply, the Bombay Government, in their despatch of 5th April, 1883, stated their willingness to give the scheme a trial.

In this way, after no little labour and negotiation, every interest and every authority in India has been brought into substantial agreement as regards the scheme. And on the 31st May, 1884, a despatch, signed by the Viceroy and his colleagues, was forwarded to England, setting forth fully the circumstances of the case, and asking the sanction of the Secretary of State to the proposed experiment. "We are anxious," they said, "to give effect to a scheme which we believe to be advocated on purely disinterested grounds, which can, under the experimental conditions proposed, be carefully watched, and which is likely, if successful, to be productive of much benefit to the country." Nothing now was wanted except the formal sanction of the India-office. But this was just what we could not get. How the project suffered shipwreck, and how our labour came to nought, I will presently relate. But before doing so I ought briefly to describe the friendly reception which was accorded to the scheme by public opinion in England. While the negotiations were still proceeding in India I went home on furlough, and was asked by the bank promoters to do what I could to make the scheme known in England. Accordingly, on arrival, I communicated the whole circumstances to two of India's best friends, Mr. John Bright and Sir James Caird. They sympathised warmly in the scheme; and Mr. Bright consented to take the chair at a meeting held at Exeter Hall on the 5th July, 1883, under the auspices of the East India Association, when I read a paper on "The Poona Ryots' Bank." A discussion followed, in which Sir James Caird and other high authorities took part. The chairman's speech, and the debate generally, were strongly favourable to the scheme, and next day the *Times*, *Daily News*, *Standard*, and other London papers gave their approval to the proposal. Next it was necessary to make the scheme known in Lancashire. And accordingly, on the invitation of the Directors, I read a paper before the Manchester Chamber of Commerce, under the presidency of Mr. G. Lord, the chairman. The paper was entitled "Government Concessions to Agricultural Banks in India." A resolution in cordial support of the scheme was moved by Mr. John Slagg, then senior member for Manchester, and seconded by Mr. (now Sir William) Houldsworth, M.P., and was carried unanimously. And in accordance with a further resolution this expression of opinion was forwarded to Her Majesty's Secretary of State for India. Further, a Corresponding Committee was formed, including the Chairman and Deputy-Chairman of the Chamber, in order to give the scheme continuing support. Finally, with a view to placing the bank's debentures on the English money market, it was thought desirable to approach the authorities of high finance in London. Accordingly, on the introduction of Mr. Bright, I had an interview with Sir Nathaniel Rothschild, M.P., who had already expressed himself interested in the subject. He informed me that, if addressed by the authorities at the India-office, and satisfied regarding the terms that would be granted, he would be prepared to give the scheme favourable consideration. He added that if the terms seemed satisfactory from a financial point of view, he did not think there would be difficulty in obtaining the capital necessary for the proposed experiment.

There only remains to tell the sad conclusion of the tale. I have to show you how the scheme to establish agricultural banks in India was defeated: how our poor little ship, the object of so much care and labour, was wrecked almost in sight of land. In order to properly appreciate the action of the India-office in this matter, it is necessary to bear in mind its position and responsibility with regard to this movement in relief of the ryot. We must remember that the great mass of the Indian peasantry are in a condition of extreme danger; they have no savings or stock of food, and consequently die in hundreds of thousands if there is one failure in the periodical rains; worse still they cannot hope to make savings, being deeply sunk in debt, while their ancient system of credit has been shattered by the action of our civil courts. For all these matters the Government is directly responsible, both as general landlord and as the sole depository of all political

power. Fortunately a remedy exists by which this danger may be averted and the ryot placed in a position of safety; this mode of treatment has been tested under the most varied circumstances, and has invariably proved successful in practice; and in every civilised country the duty of the State to see this remedy applied is acknowledged. In India the authorities are desirous of giving the remedy a trial in a cautious experimental way; all public opinion in India and in England has declared itself in favour of the movement; only the India-office at Westminster stands in the way, and forbids the experiment to be tried. It seems almost incredible, but such is the fact. How the scheme was baffled by delay; how the promoters were wearied out by interminable correspondence on theoretical points of difference; and how finally the proposals were met by a point blank refusal, will be found set forth in a Blue-book of 72 closely printed pages, obtained at the instance of our present chairman. The final answer was given on the 18th of August, 1887, in the House of Commons, by the Under Secretary of State for India, in answer to the following question, of which Mr. S. Smith gave notice:—"Looking to the indebted and depressed condition of the Indian ryot, to ask what steps are being taken to carry out the practical experiment proposed by the Government of India in their despatch No. 658 R. of 5th December, 1882, with a view to introducing into India the system of agricultural banks which have proved so useful in Germany and elsewhere in providing the peasantry with capital at moderate rates, and in protecting them from the exactions of small usurers." To this Sir John Gorst's answer was that "the proposals made in the letter referred to by the Honorable Member were carefully considered in 1882 by the Secretary of State in Council, with the result that it was determined that they were not capable of practical application." Now, was not this a most extraordinary answer, and a most extraordinary decision? These gentlemen sitting at Westminster had not been in India for years; they were not practical bankers; they had no special knowledge either of the continental system or of the banking requirements of the Poona district, where the experiment was to be made. Yet they assumed to know what was practicable there better than the bankers of Poona and the Government of Bombay: they made up their mind that agricultural banks could not be introduced into India, and decided that the Government of India must be prevented from making the attempt. What were the reasons for such an unusual exercise of authority? Was it denied that the ryot was urgently in need of help? No. Was it pretended that the objects aimed at were not most beneficial and most important? No. Was it alleged that the proposal of the Government of India trenched upon any accepted principle or policy of Indian administration? Again, no. The reasons for the refusal are set forth in the India-office Despatch No. 95, of 22nd October, 1884; and it will be found that the objections refer to matters of detail, and are of a speculative kind. For example, it is objected that the scheme professes to be one of private enterprise, whereas in reality the bank will be a Government institution; again it is contended that the financial calculations of the Poona bankers do not show that the business will be profitable; and it is argued that the condition of the ryot is either too good or too bad to be suitable for the operations of an agricultural bank. The only objection that can at all be called a practical one is that which has reference to the coercion of defaulting debtors, and this objection is founded upon a misconception. The despatch takes exception to the proposed concession under which the bank's advances may, in the case of a defaulter, be recovered as a revenue demand. This is objected to from the fear, to use the words of the despatch, lest Government should "incur all the unpopularity and odium of collecting debts which, though private obligations, are treated as public demands." This objection evidently arises from a misapprehension, the Secretary of State being under the impression that the Government proposed to undertake the collection of the bank's debts. There could not be a greater mistake. Both the distribution and collection of the bank's advances was to be done entirely by the paid agents of the bank. The question was one of jurisdiction, not of collection. With its moderate rates of interest, and with its desire to show forbearance to its debtors, the bank expected very seldom to require any compulsory process. Still it was necessary that some ultimate means of coercion should exist; the only question being whether this compulsion should come through the costly and cumbrous machinery of the civil court, with its lawyers and bailiffs, warrants and executions, and sales of land; or whether it should come through the simpler and cheaper methods of the revenue courts, in which case the village officers

would exercise their customary authority, preventing the defaulter removing his crops until he had paid the instalment due to the bank. All that the Government of India proposed was that when compulsion was required, the less grievous method should be preferred, the method which Government itself employed when recovering its own agricultural advances from defaulters. As regards "unpopularity and odium" arising from coercive process, Government will have to bear that, whether the jurisdiction is exercised in the judicial or in the Revenue department. The masses in India make no distinction between the Revenue and judicial departments; to them these two departments are equally the "Sirkar" or Government, while the educated classes know that the Executive Government, as the sole legislative power, is responsible equally for the constitution of the courts and the revenue administration. The only difference is that if the Revenue machinery is employed there will be less friction and less hardship, and consequently the unpopularity and odium falling upon Government will be less in amount.

I do not know whether I need say anything further in answer to this objection. But perhaps the situation may be made more clear by the help of an illustration which I have already employed. Let us suppose that Government, wishing to irrigate certain thirsty lands, puts up a great pumping engine to raise and distribute the water, intending that this machinery should be worked by its own servants. But its servants, not being professional engineers, are unable to work this machinery successfully. Consequently the land remains unirrigated. In this difficulty a respectable and competent firm of engineers come to the help of Government, and offer to carry out the work of irrigation upon the lines approved by Government. The Government gladly accepts this offer, and recommends that the engineers should be allowed the use of the machinery for this purpose. Would it not be considered the height of absurdity if the India-office refused to sanction this arrangement? Yet such a refusal would be on all fours with the present case. To supply capital to the ryot, Government is willing and anxious to advance cash out of the Treasury, and to employ the time of their revenue officers in distributing and collecting these advances. Further, Government passes a law to make such advances recoverable as arrears of revenue. But experience has shown that revenue officers have neither the time nor the qualifications for successful money-lending. So Government welcomes the offer of the Bank promoters, who are experts in this business, and are willing to carry out the objects of Government. Originally the Government was willing to do the whole work itself. If it is relieved of three-quarters of the burden why should it hesitate to bear the remainder? The Bank promoters are willing to give their professional skill; to bear the cost of distribution and collection; and to risk their own money instead of the money of Government. There is no reason why Government should hesitate to do what remains to be done, and give them the free use of the simple and effective machinery provided by law for the recovery of agricultural advances; The more so because without these facilities the bank would be driven to employ the costly and oppressive machinery of the civil courts, and thus create afresh for the ryot the very evils which we desire to remove.

For any further discussion of these questions I would refer to the Blue-book, where the objections raised by the India-office are patiently and fully answered by the Poona Committee. But I do not attach much importance to any dialectic victory in such a controversy. Our main contention is that the time for academic discussion is long past. What we now want is a practical experiment. It is the old story of the live fish and the full bowl of water. The philosophers proved, by good metaphysical arguments, that if the fish was put into the full bowl the water would not overflow. And this held good until some one of less subtle mind tried the experiment and found that the philosophers were in the wrong. So, in the present case, we desire to bring the question to the test of experience. We want a pioneer bank to be started, without delay, on the lines above indicated, and we believe that in this way a system will gradually be worked out free from practical objections and well suited to the special needs of the Indian ryot.

My story is now ended. I have tried to bring before you the terribly precarious condition of many millions of our fellow citizens—gentle, industrious, law-abiding peasants. And I have indicated one of the measures most urgently required in order to place them in a position of safety. We do not say that this remedy alone will produce prosperity. Many other reforms are urgently needed. But this measure is so simple and practical, so completely in accord with the general policy of the administration, so free from any collision with

vested interests, that its immediate adoption seems quite unobjectionable. It is indeed surprising that any one should be found going out of his way to oppose such an interesting effort of self-help and public spirit. In conclusion, I would most earnestly ask you to bring public opinion to bear upon the India-office with regard to this great economic question. The present time is most opportune for two reasons: 1st, because even now the shadow of famine is over the land. No doubt the public officials will do what they can to save life and relieve suffering. But this will be done at a vast expense, which can ill be afforded. We want to remove the originating cause of such disasters, instead of merely mitigating the effects by means which pauperise and degrade. And the second reason is that public attention in India is now being particularly directed to the necessity of organising agricultural credit. The subject was prominently brought forward at the recent Poona Industrial Conference. And, at its last session, the Indian National Congress included the establishment of agricultural banks in its programme of Indian reform. I also observe, with much satisfaction, that the Madras Government has taken up the subject, and has appointed a special officer, Mr. Nicholson, to collect information regarding agricultural banks, at home and abroad, and formulate a scheme for the consideration of Government. May the scheme prosper; and when it comes up for the sanction of the India-office, may the authorities look favourably on it, not unmindful of the injunction of the Eastern law-giver, whose words seem intended for the present case: "Thou shalt not harden thine heart, nor shut thine hand from thy poor brother; but thou shalt open thine hand wide unto him, and shalt surely lend him sufficient for his need."

DISCUSSION.

Lord REAY, G.C.S.I., said he had great pleasure in thanking Sir William Wedderburn for having again revived this important subject. It was not a new subject to either of them, as they had treated it officially, and therefore, he was very glad to greet it on that platform as an old friend. He should have preferred to hear the arguments against the scheme by many gentlemen present with longer and wider experience of India, but unfortunately, he had to attend another meeting, and before leaving he wished to support in the main the views which had been enunciated in the paper. It was impossible at such a meeting to enter into the details of the Purandhar Taluka scheme, and he thought his learned friend had very wisely abstained from giving the details. What the meeting had to do was to show their sympathy for the main principles stated in the paper, that it was the duty of the Government in India to assist institutions which rested on a solid financial basis, and which had for their object to give credit, at a low rate of interest, to its agricultural subjects. The Government of India had a direct interest in good agriculture, and solvent occupiers were the first condition of good farming. When in England they were placing the credit of Government at the disposal of proprietors who did not as yet exist, surely in India they might place the credit of the Government at the disposal of existing proprietors, in order to keep them on their legs. Without some such scheme being adopted, as had been pointed out before, there was great danger that the ryotwari system in Bombay would be transformed from a small-holdings system into a zemindari system of larger properties—a transformation which everyone would deprecate. It would be a curious comment if, while legislation was all in the direction of creating a smaller proprietary in England, we should do nothing to prevent small properties being absorbed by capitalists in India. This was actually going on in the neighbouring districts of Bombay. With reference to the statement in the paper of the large amount of money locked up in the banks, this statement probably referred to certain periods of the year. It was due to some fault in our banking system that at times there was such a glut of money that the rate in Bombay fell to 2 per cent., when the rate in London was higher. But at times, when the export trade was brisk, the rate of interest rose considerably. This was an important banking question, and he merely alluded to it to show that they had to deal with very great fluctuations in the rate of discount. There was one omission in the paper to which he should like to refer, as it related to a somewhat important matter. Sir William stated that the friendly relations between the debtor and the money-lender were increased by the fact that under native Governments, and in the earlier days of British rule, disputes between them were usually disposed of by arbitration. But one of the objects of the Deccan Relief Act, which had not been mentioned in the paper, was to restore arbitration. The Act did establish conciliators for that very purpose. He supposed Sir William would retort that the clause of the Deccan Relief Act had remained a dead-letter; and he was afraid there was a great deal of truth in this, but, at the same time, the fact remained that the Indian Legislature certainly wished, when that Act was passed, to establish a better and inexpensive form of procedure between debtors and creditors. No doubt Sir William would also say that the Deccan Relief Act impaired the credit of the ryots, and made it more difficult to obtain money at easy rates. But to this the answer would be that it certainly was not in the

interest of the ryots to increase unduly the facilities which create a condition of insolvency which place him in a helpless situation at the mercy of the money-lender. With regard to the statement as to the bank in Hungary having the right to foreclose, he should like to have some assurance that it was not proposed to give a power to the banks in India of foreclosing without going to arbitration.

Sir WILLIAM WEDDERBURN—Certainly not.

Lord REAY said that in France an experiment had been made by the Bank of France, which advanced in the Nièvre money upon condition that the directors of the Agricultural Society of that Department, who were well acquainted with the financial position of every farmer and landlord, gave their signature. The bank advanced money to the advantage of the agriculturists of the district with perfect safety. If by any chance those who might speak after him were of opinion that this experiment should be tried, not in a whole *taluka*, but on a smaller scale, Sir William would probably not object to this. Like many other questions in India, the present question could only be solved by experience, and, therefore, it was important that we should make some beginning, and cease the triangular correspondence between the Government of Bombay, the authorities at Simla, and the India-office. It was possible that, in some parts of India, the conditions under which this experiment could be tried would be more favourable than in so poor a district as the Deccan. There was one difficulty which he did not want to obscure. He saw it stated that the village money-lenders were prepared to co-operate in this movement. This was a very important statement, because, from the dim recollection which he had of some of the records upon the subject, he knew it was one of the most formidable arguments raised, that, from the moment the bank charged 9 per cent. interest, the money-lenders would charge 8 per cent. or 7 per cent. By this means the scheme could be imperilled if not defeated. If the money-lenders were given some position in the bank, this might be avoided, and their knowledge would be useful. Notwithstanding all his efforts to encourage takavi advances, there was not much progress made; and one of the difficulties was, that the native officials, on whom the responsibility mainly rested of carrying them out, were reluctant, being afraid that the advances might not be repaid when the time came. It was, however, the duty of the Government to face a certain amount of risk where these advances were needed by deserving agriculturists, especially to counteract the influence of bad seasons.

Sir CHARLES BERNARD, K.C.S.I.—I am sure that we of the Indian Section of the Society of Arts are deeply indebted to Sir William Wedderburn for the very interesting paper we have just heard. As he says, the indebtedness of the classes connected with the land is one of the most important of Indian questions. The ryots of India will ever be grateful to Sir William Wedderburn and his Poona friends for the zealous and able way in which they have investigated the subject and placed it before the public. Sir William has unfolded his view of the case with a clearness which we must all acknowledge, but I am not sure that the whole case has been fully stated. Much fault has been found with the action or inaction of the India-office. I have no brief to defend the India-office, which, being absent, is naturally found to be in fault. But these things were not done in a corner. The grounds on which the India-office acted are explained in papers presented to Parliament nearly six years ago, at the instance of our chairman, whose sincere interest in the welfare of our Indian fellow subjects we all acknowledge, and to whom we are most grateful for being present this evening. All who are interested in the subject have no doubt read this Blue-book, and I will not trouble you with any discussion thereon; but it is perhaps worth mentioning that Lord Kimberley's despatch of November, 1884, of which the reader of the paper has spoken, recognised most emphatically the importance of the question, signified a disposition to entertain favourably any practical proposal for the relief of the Indian peasantry from indebtedness, and promised the most careful attention to any revised scheme for promoting the objects in view. I may not trouble the meeting with general remarks regarding the Indian village banker, who is by no means the wealthy Shylock that he is often represented to be. His services to the landed classes are most valuable; he keeps the ryot and his family on their legs; without his assistance the village polity could not be kept going; and though his rates of interest may sound high to English ears, yet there must be many counterbalancing losses in his business, for the Indian village banker usually lives poorly, and is very rarely a rich man. Nor will I stop to point to the risk of making borrowing too cheap and too easy for the ryot. In Burma, where the interest on rural loans ranges from 2½ to 5 per cent. per month, even where good security is given, it has been found that only 2 per cent. of the ryots were hopelessly involved, while only 15 per cent. owed more than they could repay in a single year. Many of us believe that the Indian peasant would not have been indebted to the extent he now is, if he had not been prematurely enabled by British laws to borrow money easily on the security of his land. As has been said, Lord Kimberley invited the submission of a revised scheme from India, but, as yet, such is the difficulty of the subject, no revised scheme has been matured. I hope that some scheme of the kind may soon be forthcoming. The reader of the paper mentioned that Mr. Nicholson, of the Madras Revenue Service, who has closely studied the subject of agricultural banks in Italy and Germany, and has published interesting papers thereon, has recently been deputed by Lord Wenlock to report upon the matter; and

received a letter from him last week, saying that he hoped soon to have his report ready. So I trust that before long a revised scheme, such as Lord Kimberley suggested, may be received from India. Like most other Indian revenue officers, in more than one province, I have had to consider the question of rural inbebtedness, and watched with great interest the Poona discussions and proposals. I was employed in another part of India when those proposals were sent home, and when Lord Kimberley's despatch came out; and I confess to having felt relieved when it became known that the Poona proposals were not to be carried out in their entirety. The Purandhar scheme was intended to be a pioneer scheme, on which, if it succeeded, similar arrangements for other parts of India might be modelled. Yet the authorities who sent forward that scheme admitted the questionable character of some of its provisions, and were careful to say that they could not undertake to apply those questionable provisions to other parts of India. To me it seemed that the Poona scheme could not have been practically successful, and could never have been made generally applicable to other parts of India. If my view—which was probably shared by many revenue officers—was correct, then the Poona scheme, if it had been sanctioned, might, by its failure, be thrown back. The shortcomings of the Poona scheme were, to my mind, these:—First, the undertaking was on too big a scale, and tried to do too much at the outset. A general settlement and liquidation of all the debts of nearly all the ryots in the country treated was to be made. The settlement was to be made by the executive officers of Government, and the money was to come from the funds of the general taxpayer. Then the bank was to come in—was to give fresh loans to the ryots, who had thus been made solvent, and was, by and bye, to pay off the money advanced by the Treasury, if it could. No doubt the tract would have been solvent and prosperous for a time, and the ryots would have merrily contracted fresh debts to the bank, which, in its turn, was to borrow money on debentures in England. But if the advance made by the general taxpayer was ever repaid, I fear the last state of the tract would have been worse than the first. I question if English capitalists would have advanced money to the bank without some understanding with the Government, which would be interpreted into a Government guarantee directly the bank got into difficulties. Some proportion—possibly a considerable proportion—of the borrowing ryots, who had been taken in the mass without selection, would be behindhand with their payments, from one cause or another, and so the difficulties of the bank would begin. In Germany, and especially in Italy, where circumstances most resembled Indian facts, the rural banks began on a small scale. There were a great many of them, they were managed by local people, and they got the local money-lenders and the local farmers to take shares; they began with only a few clients at first, and they gradually—though, in most cases, very rapidly—extended their business. In India, too, the business must begin on a small scale, and tentatively; and it should not be heralded by a general liquidation of all rural debts at the cost of the general taxpayer. Each bank or local branch should secure the co-operation of one or more of the village bankers and solvent ryots as shareholders; these men would know what ryots could be trusted and what could not. For the rural banks, if they are to succeed, must select their clients; and with a number of local shareholders—as in Italy—the banks would be likely to select discreetly and to exercise constant vigilance over borrowers. Secondly, the Poona scheme relied too much upon Government help. At the outset it required a general settlement of debts all over the country by the agency of Government officers and from the Public Treasury. Then —and this seems the worst feature of the whole—the executive officers of Government were to step in and realise the bank's debt from borrowers who would not pay. The process by which arrears of Government revenue are collected is, that the collector certifies as to the arrears; his certificate has the force of a decree, and can be enforced just as the decrees of a civil court are executed. Who would give the certificate in the case of the bank? If a borrower claimed that the account against him was wrongly stated, that interest was overcharged, or that his payments were not duly credited, who would try these issues? Surely the collector and his staff could not find time to try them properly. Such issues could best be decided by the civil courts. Twenty-three years ago rent suits in Bengal—which are the burning questions in that province—were transferred from the jurisdiction of the collectors to the civil courts; and it is matter of common knowledge that the poorer parties in these cases—about 200,000 suits a year—get better justice under the present system than they did under the old. So with issues between ryots and bankers, the ryots will in the long run fare better in the civil courts than under the executive arrangements of the collector. I greatly question whether the Indian Legislature would be generally ready to apply the collector's executive jurisdiction to disputes between the ryots and rural banks. It was only last month that the Indian Legislature refused to pass a Court of Wards Act for Bengal, until the Government gave a pledge to take measures for preventing arrears of rent on Wards' estates from being realised under the collector's executive authority, or under the certificate procedure, as it is called. These two faults—namely, attempting too much at once, and relying too much on Government aid—would, I believe, have wrecked the Poona scheme, if it had ever been launched. And the experience gained would only have been of a negative kind, showing mainly what courses must be avoided. If a revised scheme is brought forward of a more practical kind, under which rural banks should start from small beginnings, as purely local institutions, and under

which the banks should only have the ordinary remedy against their debtors, then, I think, the establishment of such banks should be sanctioned, as experiments, in one or more districts of every province, where the people and the collector for the time being may be ready to work the scheme. And, in that case, I think the State might reasonably help rural banks by some such concessions as the following, namely:—(*a*) The loan of public money at 4 per cent. per annum, on the security of the bank and all its assets, in proportion of one rupee of public money for every two rupees of actually paid-up private capital; (*b*) the reduction of all stamp fees by one-half, or even two-thirds, on litigation, and on deeds for a period of (say) ten years, to begin with; (*c*) the remission of registration fees on documents for five years, and the reduction of fees by one-half for five years more; (*d*) the auditing and publication of the bank's accounts by the public officers once in every half year; (*e*) the custody of the bank's cash, beyond a certain minimum, and of the bank's securities in public treasuries and sub-treasuries. As I have said, I have no authority to speak for the India-office, and I cannot say how a revised scheme of this kind might be viwed by the highest authorities, but I have, on the invitation of your chairman, so far as time allowed, expressed my own views on a subject of really paramount interest to the bulk of the Indian population.

Mr. A. ROGERS said, although he entirely concurred in the principle of agricultural banks, his chief objection to the proposed scheme for India was that the bank would be impracticable, owing to its not being able to compete with the local money-lender. In order to do this, the bank would require to have a branch in every single village. As was well known to all Anglo-Indians, almost every village had its money-lender, and this person also acted as a grain dealer and pawnbroker, and with him the ryot had a running account. It was impossible that any bank could compete with such persons. The ryot did not want a certain sum of money once a year, but a varying amount perhaps as often as once a week. It would be impossible for the bank to have branches in every village; and unless it did so, it could never compete with the local money-lender. The scheme would not thus be a financial success, and must ultimately break down. With regard to the change in the friendly relations between the money-lender and the ryot, which had been referred to, he thought Sir William Wedderburn had not traced this to its true cause. It was due to a change that was made in the law. Under the former Bombay law a running account went on for twelve years, which enabled the parties to it to look round them and arrange with each other, but upon the twelve years being cut down to three, the money-lenders, in sheer self-defence, took to putting their debtors into court and getting decrees against them. Had this change in the law not taken place, the amicable relations which formerly existed between creditor and debtor would not have been disturbed. The best thing one could do in order to restore these amicable relations would be, as far as possible, to restore the old state of the law, and allow a longer period within which the money-lender and debtor could come to terms. It was said in the paper that 40,000,000 people in India were continually on the verge of semi-starvation, but if such were the case, he thought the population would not have increased by 80,000,000 in the last decade. The Government was doing all it could in order to place the ryot in a proper position of independence. The land tenure in Bombay was most favourable; a man got a full proprietary title to his land, and could mortgage or sell it very quickly, the system of transfer being of the most simple possible description. The Government were also prepared to make taccavi advances. He could not quite understand how the pressure of population upon the land, to which the ryot's indebtedness was chiefly due, could be remedied by agricultural banks.

Surgeon-Lieut.-Colonel HENDLEY C.I.E. thought it would be better to lend in kind or seed than money. It was contrary to his experience that the agriculturist was thrifty, for he believed a ryot spent all the money he earned in times of prosperity on marriage and funeral expenses. In fact, he often went out of the way, and created the necessity for spending money. He quoted from a friend, a native noble, who stated that the cultivator did not lose by the rent, but was kept in poverty by extravagant expenditure on marriages, &c. A short time ago he himself employed a mechanic to make some brass vessels. He was very successful, and made a deal of money; but the first year he spent nearly all in celebrating his father's funeral; and he then went back to his grandfather, and spent the remainder on *his* funeral ceremony. One of his (Dr. Hendley's) clerks spent his own income, his brother's income, and that of his father for two years upon the marriage ceremony of certain of his children. In Rajputana the nobles had formed a society, chiefly under the inspiration of Colonel Walter, lately agent to the Governor-General, for reduction of such expenditure, and so far it had been worked most successfully. This showed how much they felt the necessity of reform, and he (Dr. Hendley) hoped that their good example would be followed by the lower classes. In establishing these banks, it was very necessary to see that the ryot did not have the easy handling of too much money, and that he should be kept under proper control by the village authorities. The most important point of all was to make it as difficult as possible for the ryot to get cash, though we ought to do our utmost to provide him with seed and subsistence in times of scarcity, and to teach him to be provident. The great desire of the ryots in some Native States, where the central authority was weak, was to live on the estates of nobles rather than Government land, as in the latter case the collec-

tion of the rent fell to an agent, who had no heart in the matter. One of the most important things in India was to protect the nobles and the people against the middleman. It would be more to the advantage of the nobles if we taught them less of the power of passing a successful examination at the university than how to deal justly with their ryots, and to protect themselves against the agents who preyed upon them. In some of our noble's colleges he believed this was done. Speaking for himself, he might say he was as much in sympathy with the nobles as with the ryots.

Dr. A. J. VOELCKER said that when he was in India some time ago, he tried to ascertain some of the causes of the indebtedness of the Indian people, and the conclusion he had come to was, that the existence of the money-lender was a result of the indebtedness rather than the cause of it. Money-lenders would not go to a place if there were nothing to be got from it, and one sign of true poverty was the scarcity of money-lenders. The secret of the present position of the ryots rested very much more with themselves than Sir William Wedderburn would have one believe. The principal cause of the misery was the improvidence of the people; and, if they had their old debts paid off and further money advanced, he did not believe that they would, as Sir William Wedderburn imagined, at once proceed to dig wells and to manure the land. The ryot often would not use canal water, in order to increase his crop and get more off his land, but he would only begin to use it when his crop was actually about to fail. When in Madras, he came across an interesting instance of the the cultivators of the soil combining together to form a co-operative association for the purpose of protecting themselves against the extravagant charges of the money-lenders. Instead of paying 25 per cent. or more, money was lent by the association to its members at 12 per cent. A measure like this would, he thought, go farther than the establishment of agricultural banks towards the improvement of agricultural credit.

Sir STEUART COLVIN BAYLEY, K.C.S.I., thought there were one or two points which had not yet been brought forward by previous speakers which he would refer to, and, if possible, he hoped the reader of the paper would help him to come to a conclusion upon them. He had taken a strong interest in this question from the beginning, having been a member of the Government of India when the subject was under consideration, and more especially responsible for the despatch wherein the recommendation to which Sir William Wedderburn had alluded went home. He might excuse himself now from saying anything further about that, except that he was still in principle strongly in favour of that or some similar experiment being tried. He did not recede one iota from that point of view when he said there were some objections to it which had not been properly met. The objections which the Secretary of State took would be supposed by anyone who had only heard what the reader of the paper had read, to arise from want of sympathy, hard-heartedness, and a desire to obstruct what was really an obvious blessing to the poorer agriculturists of the Deccan. The real grounds on which exception was taken to the proposal were distinctly practical. It was urged that, after the ryot had been relieved of his previous debts by Government money, he would have first of all to pay off the amount which had been advanced, and this was calculated to occupy twenty years, and during that time he would have to pay his assessment as well, so it was not quite plain where the surplus income at his disposal was to come from on which he could go to the bank and borrow. Another objection was, that the bank would come into competition with the ordinary village sowcar but would not be able to oust them; that was to say, the ryot would have to go to the sowcar for a continuous supply of petty loans, and the result would be that the latter, having had the cream of his business taken away by the banks, would be forced to increase his rate of interest, in his dealing with the ryots on the smaller matters. They were told that the intention was to bring the money-lender into connection with the banks, which was also proposed in the Ghoozerati scheme, but he had never yet seen how it was proposed to work out this plan in connection with the Purandhar taluka scheme. It was important, and he would be glad to have some further explanation of the *modus operandi*. The chief objection, however, was to the recovery of dues by the Government officials. The reader of the paper thought there must be some misapprehension upon this subject, but the papers that went home were as clear as they possibly could be about this. He did not think there could be any misapprehension upon the matter, though there might have been a difference of opinion. The Secretary of State probably imagined, that although the intention was only to resort to Government officials as a last resource, yet, as a matter of fact, when the bank found any difficulty in collecting its dues, if all they had to do was to hand the paper of claims to the collector, they would have recourse to that very simple and easy method of recovery very often. Those were not obstructive objections, but practical objections to the scheme, which had to be met, and the correspondence with the Secretary, of State so far as he knew, ended there. His own information only extended up to 1886. The case then stood thus. The Secretary of State had made his practical objections; he had asked that the scheme should be reconsidered in the light of these objections; and he further said he would be glad to give his favourable consideration to a revised scheme. The committee that had, in the first instance, investigated the scheme put forward a paper of answers; and at that stage he (the speaker) left it. He knew that the matter was referred to the Government of Bombay, but he did not know whether the committee

at Poona had ever tried to make such alterations as would meet the objections. He should be very glad if the reader of the paper could tell them exactly what had happened after that point, and also if the objections could not reasonably and fairly be met. For instance, was it essential that you should go to the revenue courts for assistance in attesting the revenue debts. The matter did not seem to him to be one so entirely for denunciation of the Secretary of State as Sir William Wedderburn would have them believe.

Sir GEORGE BIRDWOOD, K.C.I.E., C.I.E., said he was not entitled to express any opinion on the subject of Sir William Wedderburn's paper. It was true he had lived many years in India, but India was not a single country, but a continent of many countries, and you might know a great deal of one part of it without knowing anything worth acceptance of the rest, and even as regarded the Bombay Presidency his observations had been limited to but a few of the many sides of local life there presented to him. But with reference to the reflections that had been cast on what was termed the unthrifty habits of the Indian ryots, he would like to say that, so far as the ryots of the Southern Mahratta Country and the Canarese marches of Western India were concerned, they did not in the least correspond with his own experience. They were a most thrifty people, most industrious, and most enduring, while their lavish expenditure on funerals, marriages, and other ceremonial observances, was determined by their religious beliefs; and though it might waste their resources, it promoted their happiness, and would be continued so long as they remained in the faith of their forefathers, by which their lives had been regulated for nearly 5,000 years. He might say, also, that he thought Sir William Wedderburn had made out a strong case for a carefully limited experimental trial of his proposals for the relief of the almost universal indebtedness of the Indian ryots. He appreciated all the difficultles besetting the attempt. These simple people would never distinguish between the agricultural banks Sir William wished to establish and the Government. In India every man who wore a shoulder-belt and brass plate was identified with the Government; and Sir William Wedderburn would remember how, on the eve of the Mutiny, in 1857, an enterprising native swindler went all about the Southern Mahratta Country levying improvised taxes in the name of the Government, on the sole authority of a label of the Royal Arms of the United Kingdom on an empty Fortnum and Mason's, or Crosse and Blackwell's pickle bottle, in which he collected the contributions of his easy dupes. The proposed banks seemed to him somewhat unsuited to the genius of the people, and this was the fundamental difficulty of our position in India, that we were a foreign Government there, and that the ideas and institutions of our modern Western system of competitive civilisation, to which we owed our prosperity and great international position in the world, were in direct, and inherently antithetical, opposition to the whole social and economic constitution of a country still organised, throughout its greater part, on the basis of the ancient Eastern co-operative system of civilisation. Under that system, as originally developed, the law of landed tenure wae associated with the benignant provision familiar to us all under its Biblical designation of the "Law of Jubilee," by which no ryot's debt could run more than fifty years [Leviticus xxv. and xxvii.]. He did not pretend to fully understand such intricate economic questions, and did not know whether the suggestion was a sound one or not, but in treating of the picturesque aspects of Indian village life he had more than once indicated that some such conditions as those of this law of Jubilee might be introduced by us for the relief of the apparently hopelessly encumbered ryots of India. He thought also that Sir William Wedderburn had made out a strong case of the most exasperating neglect of his benevolent proposals; but this indictment lay, in his opinion, less against Lord Kimberley than the usual "cussedness" of Providence; and he felt sure that Sir William Wedderburn's present paper, and the discussion that had taken place on it, when published in the Society's *Journal*, would lead to a revival of official interest in the subject, and probably to its being once more referred by the Government of India to the India-office. At any rate, the Indian Section were under deep obligation to Sir William Wedderburn for his interesting paper; and the earnest sympathy it evinced with the people of India must have been gratifying to all present, and would secure him the unanimous and hearty thanks of the meeting. He desired also to acknowledge the obligation of the Indian Section to Mr. Samuel Smith for presiding on the occasion. Occupying the onerous and honourable public position he did, it was most kind of him to give up three ungrudged hours of his time to the service of the Society.

Mr. H. M. HYNDMAN denied that the Credit Foncier in France, or similar institutions in Germany, Austria, Italy, or elsewhere, had been of any benefit to the peasantry, as alleged by the reader of the paper. On the contrary, the Agricultural Commissions in France showed that facilities for borrowing were dangerous to the small landowners. The Imperial Commission in Germany, of which Professor Nasse was President, showed the condition of small owners in Baden-Baden and Alsace, and that of which Senator Jacini was President, the state of things in Lombardy. So far from having benefited the peasantry, the tendency had been quite the reverse. The creation of land banks in India of the kind advocated by Sir William would, he feared, increase the domination of the towns over the country, and slowly drain away the substance of the peasantry still more. If, by the establishment of a

bank, the rate of interest now charged by the money-lender was cut down, some good would be done; but he should be very sorry to see the plan introduced into India, as it would have other effects, which would be injurious.

The CHAIRMAN thought the paper must have impressed everyone, as it dealt with a question of vital importance to India. The most pressing question was the poverty of the peasantry and their indebtedness. It was true there might be many difficulties in the way of remedying this, but he thought the lines upon which Sir William Wedderburn had advocated relief were, in the main, sound, though whether they could be carried out to the extent suggested was not in his power to say. He certainly thought the experiment ought to be tried. It was to be extremely regretted that, from some fault or other, for ten years the valuable suggestion which had been made should, through the action of the home Government, have remained a dead-letter. He hoped the discussion that day would do something towards reviving interest in the question, and that they would be able to press the Government to remove any impediments which they might have placed in the way of the authorities in India. It struck him that the Indian Government was far more competent to judge of this matter than the English Government. In conclusion, he begged to propose a hearty vote of thanks to the reader of the paper.

Sir WILLIAM WEDDERBURN, in reply, said that, in his opinion, the Poona Committee had given satisfactory answers to all the objections raised by the India-office. The correspondence would be found in the Blue-book. The promoters, however, did not attach much importance to a victory in this academic discussion. What they wanted to do was to try a practical experiment. In India things seldom turned out as was expected even by the most experienced officials. For example, it was believed that the financial difficulties of the ryot would be best relieved by an Insolvency Act, and accordingly insolvency clauses were introduced into the Deccan Relief Act. But not a single ryot would accept the benefit of its provisions. Two or three ryots were declared insolvent by the court, but it was done against their tears and protestations. They said they would be disgracing their ancestors if they did not pay their debts, as religion required, and that they were being ruined both in this world and in the next. To go on arguing about matters of detail was waste of time. The thing was to set the bank going, when the real difficulties and the best remedies would come to light. He was grateful to the gentlemen who had taken part in the discussion. Sir C. Bernard had said the promoters proposed the experiment on too large a scale. To that he would reply that this objection had never been taken before. Also they were quite willing that the experiment should be tried on a smaller scale, say in a group of villages, provided a real genuine experiment was made. Then it was objected that the money-lenders would not come into the scheme; but the fact was the money-lenders had already agreed to co-operate, for they saw that as shareholders in the bank it would be more profitable for them, lending borrowed funds instead of their own capital. It was only when the local money-lenders had agreed that the deputation of bankers, money-lenders, and ryots waited on Sir James Fergusson. The scheme was mainly decreed by experienced native pensioned officers, revenue and judicial, who were thorough men of business, who had themselves carried on the administration of the country and knew the needs of the people. The interminable correspondence, lasting over five years, had wearied out the promoters. The chairman, a leading banker of Poona, had died during the negotiations, and others had got disgusted by the obstruction and delay. That was how the scheme was defeated. With regard to the action of the French Credit Foncier, to which Mr. Hyndman referred, it would of course be necessary to guard against the tyranny of large capitalists as against the tyranny of small capitalists; but, in this particular case, it was proposed to place the management of the bank in the hands of a class of men who had the complete confidence of their fellow citizens. He had purposely omitted reference to the Deccan Relief Act, because it was a very controversial question. Also although the Act did something to disarm the creditor, it also struck at the credit of the ryot. He agreed with Mr. Rogers, that the shortening of the term of limitation had done great mischief to the ryot.

The vote of thanks having been unanimously agreed to, the meeting terminated.

TWENTIETH ORDINARY MEETING.

Wednesday, May 11, 1892; Prof. WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Castle, Sydney C. C., 40, Chancery-lane, W.C.
Gubbins, John Harington, British Legation, Tokio, Japan, and Oriental Club, Hanover-square, W.
Smith, Sir Donald A., K.C.M.G., LL.D., Montreal, Canada.
Woolf, M., 16, Greville-place, N.W.
Young, Herbert Edward, White Hart-street, High Wycombe.

The following candidates were balloted for and duly elected members of the Society:—

Collins, Ernest, The Gables, Wedderburn-road, Hampstead, N.W.
Deverell, Frederick Harold, The Custom-house, E.C.
Dowling, Dennis John, Bromley, Kent.
Elworthy, Herbert S., care of William Watson and Co., Bombay, India.
Fowler, Alexander Farquharson, Highfield, Ashton, Preston, Lancashire.
Gray, Robert, Glenclune, Port Glasgow.
Grinlinton, J. J., care of Messrs. Darley and Butler, Billiter-square-buildings, E.C., and Colombo, Ceylon.
Grover, Colonel George Edward, R.E., British Section, World's Columbian Exposition, Chicago, U.S.A., and United Service Club, S.W.
Gwynne-Griffith, J. St. A. Mansel, Hendre-Owen, Bedford-park, Chiswick.
Hutchinson, Surg.-General Robert F., M.D., 35, Clanricarde-gardens, W.
Ismay, Thomas Henry, J.P., D.L., Dawpool, Birkenhead.
Jones, Julius Marris Wilson, 309, Kennington-road, S.E.
Kempster, William Henry, M.D., Oak-house, Battersea, S.W.
Osborne, Major-Gen. W., United Service Club, S.W.
Rollit, Sir Albert Kaye, M.P., LL.D., Dunster-house, Mark-lane, E.C., and Cottingham, East Yorks.
Sandell, Henry William Adrian, M.R.C.S., L.R.C.P., Leighton Buzzard, Bedfordshire.
Saubergue, Arthur de, 3, Victoria-street, S.W., and Barbadoes, West Indies.
Sherwell, John William, Saddlers'-hall, 141, Cheapside, E.C.
Tonks, J. William, Vittoria-street, Birmingham.

The paper read was—

THE USES AND APPLICATIONS OF ALUMINIUM.

By G. L. Addenbrooke.

The utility of a metal in the arts is governed by its physical properties, and the price at which it can be produced in an available form. I propose, therefore, as a commencement, to deal with both of these aspects of the question this evening, in order that a fairly correct basis may be arrived at on which to estimate the uses to which aluminium is applicable; and, in what I say, it must be understood that I refer generally to aluminium itself, or to aluminium alloyed with a few per cent. of other metals, unless it is mentioned to the contrary, and not to aluminium bronzes, or bronzes consisting chiefly of copper alloyed with a few per cent. of aluminium.

Let us commence with the cost of the metal, as that so largely determines its sphere of usefulness. Just three years ago, in this room, Mr. William Anderson described the Deville-Castner process, which had then just been put in operation by the Aluminium Company of Oldbury, near Birmingham. It was then stated that it was proposed to manufacture aluminium at 20s. per lb., or at about one-third of what its price had been previously, and still leave a satisfactory commercial profit. These anticipations would have been duly realized but for the contemporaneous perfection of the electrolytic methods of reducing aluminium, which, being brought into use on a large scale, have resulted in an enormous reduction in the cost of production, and this has constantly reduced the market price of aluminium in a manner which is probably without parallel in the industrial history of metals. Starting three years ago, as has been mentioned, at 20s. per lb., the price of aluminium quickly fell to 15s., then to 12s., next to 8s. and even 6s. It was thought, about a year ago, that the climax, for the time being at any rate, had been reached, when the Pittsburg Reduction Company of Pittsburg, Pa., announced that they were prepared to supply aluminium at a dollar, or 4s. 2d. per lb. But the competition chiefly of the Aluminium Industry Company of Neuhausen, Switzerland, whose works are operated by water power and are on a large scale, has led to still further reductions, and at present, in considerable quantities, aluminium of 99 per cent. guaranteed purity is obtainable at 2s. or even less per lb.

On anything like the present output this price is hardly a remunerative one for the companies engaged in production; and it seems to me that it is improbable that there will be much greater reduction at present. On the other hand, I do not think the price is likely to rise very much again, because a larger consumption of the metal would make this rate a paying one, which would lead to increased output. This, then, is the cost basis on which we have to estimate the openings for aluminium during the next year or two, a cost, bulk for bulk, not greatly exceeding that of copper, for at present the cost of copper is about 5d. per lb., and, since it is $3\frac{1}{2}$ times as heavy as aluminium, the latter, at 2s. per lb., would equal copper a $\frac{24 \times 2}{7}$ = say 7d. per lb., or a relative cost for equal quantities of as 5 for copper is to 7 for aluminium.

It may be interesting to outline briefly the processes by which these astonishing results have been obtained, particularly as finality has by no means yet been reached; and should the uses of aluminium warrant a largely increased output in the future, considerably better economical results could be attained.

As usual, success has been achieved by the labours of many minds, but there are two patented processes under which most of the aluminium at present made is being manufactured. The first is that of Mr. Hall, of Pittsburg, Pa., whose patents are owned in America by the Metal Reduction Company of Pittsburg, and in England by the Metal Reduction Syndicate of Patricroft, near Manchester. The second is that of M. Heroult, a young French engineer. This latter process is controlled by the Société Electro-Metallurgique of Troyes (Isere), in France, and by the Aluminium Industry Company of Neuhausen, Switzerland, at which latter works the largest plant in the world for the reduction of aluminium and its subsequent working is situated.

Although, however, two in name, there is, in fact, very little difference between these two processes, so far as the details have been made known, and therefore, for my purpose this evening, one description will answer for both.

In both cases the oxide of aluminium, or alumina, $Al_2 O_3$, is the material from which the metal is reduced. This is dissolved in a fused flux, consisting of fluorides of aluminium and sodium, which simply serves as a vehicle to carry the alumina. The furnace for effecting the operation is made in the form of an iron-cased box, which is thickly lined with carbon, having a cavity in the centre into which the materials for reduction are introduced. Two or more of these furnaces are placed in series, and one pole of the dynamo is connected to the carbon lining of the first, forming the kathode. A large block of carbon carried on an adjustable support, and arranged so that it can be dipped into the central cavity of the furnace, forms the anode, from it connection is made to the lining of the second furnace, and from the carbon anode of the second furnace, if there are two, the main passes back to the other terminal of the dynamo.

In starting the plant, the carbons are brought well down in the furnaces, and the current turned on. At first considerable resistance is offered, but as the materials in the furnaces get warm this decreases, and the carbon anode can be raised somewhat. Decomposition takes place at about a full red heat, the alumina is resolved into its elements, the oxygen partly unites with the carbon, and is given off as carbonic oxide, and partly escapes free, while the aluminium sinks to the bottom, and gradually accumulates. When a sufficient quantity has collected, it is tapped off and run into moulds without interrupting the process of reduction, which is thus continuous. As the aluminum in the furnace is decomposed, the resistance rises, as the workman can see by watching the ammeter, and this is an indication to him to add more alumina.

It will thus be seen that the process is a pretty simple one. First, we have the dynamos, which must be driven by steam or water power, and which, as they are operated continuously, can be worked to the best advantage. The load is fairly even, and therefore the wear and tear on this part of the plant should be small. Then we have the furnaces, which are not expensive, and will only require the carbon lining and anodes renewed occasionally. Lastly, the flux, acting simply as a carrying vehicle, needs only small additions from time to time. The four great items in the cost of production of aluminium are, therefore, the cost of the electric energy, of the alumina required, wages and superintendence, and depreciation and interest on capital employed.

Now, in the Hall process, it is found that 22 electric horse-power flowing through the bath, at a potential of 8 to 10 volts, for one hour, is what is required to reduce 1 lb. of aluminium, and this can easily be produced by the combustion of half a hundred weight of coal, which, at 10s. per ton, means a cost of 3d.

As to the alumina, I am informed by the Metal Reduction Syndicate that the anhydrous alumina which they use, and find most suitable, on account of its freedom from impurities, costs £30 per ton, and yields about 50 per cent. of its weight in aluminium. The cost, therefore, of the raw material is at present about 6d. per lb. for the aluminium contained.

The cost of the pound of aluminium then totals up to 2s. 9d. per lb. for the aluminium extracted, unless indeed water power is employed, as at Neuhausen, where the first item is of course considerably reduced.

Coming now to the capital required, a horse-power of plant, working for 24 hours, produces, in practice, about 1 lb. of aluminium. Supposing the plant works 300 days a-year, we

have 300 lbs. of aluminium as the product of an indicated horse-power of plant working for a year. Now, such a plant as this could easily be erected complete, including buildings and all accessories, for £30 per indicated horse-power available; and supposing we take upkeep at 10 per cent., and interest and profit at 10 per cent., this represents £6 per annum to be spread over 300 lbs. of aluminium, or 5d. per lb., which is a very liberal estimate, and may well include the cost of carbons and fluxes. For these three items then we have a total of 1s. 2d. per lb. Finally, come labour, superintendence, and administration expenses. These so much depend on the output, which at present is small, that I shall not attempt to estimate them. It will be sufficient for my purpose if I have shown that the present price of aluminium ingots, say 2s. per lb., cannot leave much margin of profit on the present rates of output, which are about as follows:—The Aluminium Industry Company, 1,000 lbs. per diem; the Pittsburg Reduction Company, 600 lbs. per diem; the Metal Reduction Syndicate, of Manchester, 300 lbs. per diem; Cowles Company, 600-700 lbs. in alloys. At the same time it is sufficiently near the remunerative level to prevent any great advance, except by a reduction of output, or some agreement amongst manufacturers.

To get further cheapness, a larger demand and production are needed, which must come within a moderate time, when we may safely calculate on aluminium comparing at any rate on equal terms with copper as to price for equal bulks; but from what I have shown I think it is pretty clear that we cannot look for much reduction on the price I have named in the immediate future. Improvements will certainly take place in the processes of manufacture, and I feel very hopeful of them, but they will probably be in details rather than in any fundamental alteration of the present electrolytic process of reduction, and will chiefly take the form of improvements in the methods of obtaining pure alumina or some other salt of aluminium, and in the method of operating the furnaces, in which at present only about 25 per cent. of the energy is utilised for reduction directly, the rest being absorbed in heating the materials. Electric heating has so far been, I believe, found preferable to direct heating, but I cannot help thinking that, at any rate where steam engines are employed, further experience will lead to improved forms of apparatus being devised, which will admit of the heat required being applied directly and more economically than through the intermediation of a steam-engine, which, as a heat producer, is so very inefficient.

To pursue these lines of thought further would be speculative, whereas my object this evening is of a more practical nature; therefore, having settled on an approximate price at which aluminium will be obtainable for present use, it remains to be seen what field this price, coupled with its peculiar physical and mechanical properties, will enable it occupy.

Within the last ten years the quality of metal manufactured has been very much improved, and the larger quantities in which it has been dealt with have given better opportunities of estimating accurately its nature than was possible before. Most of the metal made is now of over 99 per cent. purity, and the reduction in the amounts of iron and silicon contained in it, which are the chief impurities, has altered and improved its working qualities considerably, when it has to be rolled, spun, and drawn.

To show exactly what its properties are, I have here a cast bar of pure metal, about ½ in. wide, ⅜ in. thick, and 1 ft. long. Taking the ends of that in my hands, you will see that I can bend it double, bringing it into the form of a rather elongated **O**, without breaking; that is about the limit of what it will stand. As regards hardness, it is rather softer than copper, and in the lathe, or under the file, behaves in much the same way, having a strong tendency to pull, and tear, and clog the tools. Like copper, too, it is softened by being plunged hot in cold water, and hardened by being cooled slowly.

Clearly, in this state, it is not very suitable for castings, and, just as zinc and tin are added to copper to improve its qualities, so some similar additions must be made to aluminium, if it is to be as useful in this form as its other qualities lead us to anticipate.

In the endeavour to improve the qualities of aluminium, without detracting appreciably from its characteristic properties of lightness and incorrodibility, I have gone over some old ground, and perhaps entered a little new, and a few notes on the results of additions of other metals to aluminium may be interesting, as the literature on this subject is rather fragmentary and incomplete, and early experiments were mostly performed with impure metal.

To begin with, the pure metal does not cast quite so well, nor is it as hard or strong as when it contains 2 to 3 per cent. of silicon,

though its malleability is decreased, and it has a scratchy sandy feel.

The addition of iron appears to be simply detrimental, leading to porous castings, while the metal is of a rotten nature.

Copper gives much better results; it hardens the metal considerably, when added up to 5 or 6 per cent., after this brittleness is produced.

My experience with copper, however, is that the alloy does not stand re-melting well, but soon becomes porous; on the other hand, until it has been several times melted, and allowed to stand, scum is apt to form, and mingle with the metal, producing bad marks in the casting. The metal also still pulls in the lathe. Silver alloys with aluminium very well, but its cost puts it out of court for most purposes.

Zinc hardens aluminium, and also toughens it when added to the extent of 3 or 4 per cent., but the resulting metal is difficult to turn, and the alloy is not a very clean one; it does not stand re-melting well.

The addition of tin appears primarily to have two actions—up to 3 or 4 per cent. it makes the aluminium short, but improves its turning qualities; if 10 per cent. is added, the bar is at first as pliable as the pure metal, and of about the same strength, but if this metal is once or twice re-melted it soon becomes crystalline.

Nickel has much the same effect; when added to copper, it however produces a closer grain, though still leaving a bad surface under the tool.

Though the qualities of aluminium therefore are improved in some respects by the addition of alloys, none of them seem to produce alone quite what is wanted.

In combination, however, better results are obtainable, and I have here some specimens made by the Phœnix Engineering Company. The exact composition of these I am not at liberty to disclose at present, but it will be seen that the metal is both whiter and much harder than aluminium, while it can be turned with practically the same facility as brass, leaving as good a surface. A good example of the alloy will have a rigidity slightly superior to ordinary cast brass, though it cannot be bent to the same extent; however, it is still fairly malleable, and bears considerable extension under the hammer. As with so many other alloys, the best results are obtained after the metal has gone through a certain amount of mixing and re-melting; afterwards frequent re-melting renders it more brittle, and is apt to produce porosity. This, in fact, constitutes the chief difficulty in casting aluminium, and it is aggravated by the fact that most of the objects hitherto made in aluminium are small, while, owing to the lightness of the metal, higher heads are needed than for brass or iron; there is therefore necessarily a good deal of re-melting if metal is not to be put aside. This difficulty is, however, one which practice and the use of aluminium for an increasing number of objects will diminish.

To illustrate what can be done with this alloy, I have here a dumpy level made from it, including all the screws and working parts. Further, I have camera screws and nuts, tripod heads, and a portable galvanometer, while Mr. Dallmeyer has been kind enough to send down examples of his lenses, particularly his new ones, all the parts of which, except the tubes, have been made of this alloy. It will be noticed that satisfactory screws can be cut in the metal. I have here also a specimen of a small resistance box, of which the top is made of it, and which appears to answer very well.

The alloy will also be useful, I think, for the frames of light motors, and for some of the working parts, for parts of portable microscopes and telescopes, range finders, heleographs, projectors, arc lamps, field telegraph apparatus, stands for portable lamps, and for a considerable number of other purposes where a fair degree of strength and rigidity is needed, combined with lightness and incorrodibility.

Before passing on from the consideration of alloys, I must mention the beautiful one of aluminium and gold, containing, I believe, about 23 per cent. of the former metal, which has been discovered by Professor Roberts-Austen, and which he has been kind enough to bring to-night. In structure it is crystalline, but the interesting point about it is its beautiful rose-pink colour, which is quite different from anything that has been observed in metal before.

Of alloys with aluminium in general, it may be said that they decrease its malleability, and that, for metal which has to be rolled or drawn, it is usually expedient to employ the pure metal, in fact the purer the better. I think, however, that as the handling of the metal is better known, some of these alloys may prove useful, and provide us with harder sheets, and wires of higher breaking strain than can be obtained from aluminium itself.

Passing now from cast aluminium to rolled

and drawn. There are on the table some 5 lb. ingots cast in iron moulds, such as are used for rolling from. These can be rolled right down into sheets of any thickness cold and without annealing, of which there are several specimens before you, ranging from the ordinary grades down to one which I have, and which is only 1-1000th of an inch thick; while, to proceed further, foil can be beaten out into leaves, the thickness of which is about 1-40,000th of an inch. This leaf has almost entirely superceded silver for gilding on account of its permanence, as a good instance of which I can show you a book of leaf which was made in 1868, and has been in London since. You will perceive that it is as bright as the day it was made.

Sheets of aluminium cold rolled become very hard and quite springy, in fact their rigidity is greater than that of ordinary brass sheets. They will still stand a fair amount of bending, and can quickly be made quite soft by annealing at a temperature of about 400°. It is evident that such sheets are applicable to a number of purposes in the flat. For instance, they have been used for making canoes and the hulls of steam launches, or for parts of photographic cameras. Sheaths for holding photograph films, and a number of the parts of portable instruments, are also readily made from aluminium sheet, and it will also, I think, have a future for ornamental work for electroliers and gas brackets, especially in conjunction with iron work, with which it forms an excellent contrast; but its greatest value lies in forming the substratum, so to speak, for stamping and spinning.

Of the various useful articles which will be made of aluminium in the immediate future, it is safe to say that a large proportion will be stamped or spun, for aluminium lends itself particularly well to this work, and anything that can be so made in other metals can be carried out in aluminium. It has, like other metals, a few peculiarities of its own which require to be mastered, but when this is done, we have a metal which is as tractable in the hands of the workman as silver. As instances, there are on the table some fine stampings of a couchant lion and examples of buttons, also forks, the backs of brushes, &c., which show how much can be accomplished, and what a nice effect the work has.

Of spinnings, Messrs. Still and Co. have been kind enough to send some fine examples: there is, for instance, a stethoscope entirely spun up, including the tube and both ends, from a circular plate, such as I have here; a more perfect specimen of what can be done with a metal, and what it will stand, it would, I think, be difficult to conceive—though so light, it is yet very rigid. There are also examples of surgical specula; an ewer and basin; and, lastly, some helmets for firemen or military purposes; these, Messrs. Still and Co. assure me, they consider as strong and stiff as ordinary brass, of which there is also an example, that its weight may be compared with those in aluminium.

Then I have here an example of the aluminium flask, of which so much has been said lately in connection with the German army; it will be observed how light and strong it is. For comparison, there is another somewhat similar one of English manufacture. The uses of aluminium for cooking utensils, probably for cartridge cases, should also be noted here.

Lastly, there are some very interesting plaques and picture frames, the work of the Scovil Company of New York, which are an interesting example of scratch brush work.

Turning now to a slightly different field, here are examples of tubes. Some provided by the Mannesmann Company, as examples of their power, are 12 or 14 feet long, and of excellent quality. For the remainder I am indebted to the Phœnix Engineering Company. All these tubes, I need hardly say, are solid drawn; and it will be noted what excellent examples of workmanship they are. For telescopes, and wherever lightness is essential, they must supersede brass or German silver. Whether they will answer for bicycles still remains a moot point. I have tested two sets of tubes of the same dimensions—one of steel and the other of aluminium—in the following way. The tubes were supported in **V** groves a foot apart, and a lever was brought down on the centre of the tubes between the supports, a pad and narrow ring being used to secure a fairly even pressure. The lever was then adjusted, and it was found that the aluminium tubes stood about half the strain of the steel tubes, though their collapse was a little more complete on passing the critical point. As an instance, an aluminium tube one inch in diameter and forty mils. thick stood a strain of 200 lbs. applied in this way. This, I think, must be considered very satisfactory.

Of the applicability of aluminium to opera and field-glasses it is needless to speak, but there is an example on the table of a glass

made in 1864, which has been in constant use since. In 1870 the wheel of a carriage passed over it, but it was afterwards straightened out and made usable. It has made two voyages across the Atlantic, two across the Pacific, and has had other shorter experiences of the sea air, besides lying on one occasion for some time in salt water; this disposes of the idea that aluminium is readily spoiled by contact with sea air. For my part, I have kept strips of aluminium for two or three weeks in salt water, and have noted very little effect.

I might continue this somewhat discursive paper further, and it is obvious that I have only enumerated a few of the uses to which aluminium can be put, but I have rather relied on showing from the examples before you that aluminium is an easily workable metal, and can be worked into almost any form which metals, such as copper, brass, and silver, are capable of assuming, having once grasped which, each in his own sphere, can find uses to which it adapts itself. At its present price, it can be classed as eminently a useful metal, and the lower the price becomes, the wider will be its sphere of utility.

There is, further, one goal towards which aluminium workers will look forward, and the attainment of which it is not unreasonable to expect in the future. At present, the price of aluminium is about four times that of pure copper for equal weights, and its output is little more than a ton a day for the whole world. In the improvements in the process of reduction, and an output of some thousands of tons per annum, is it looking too far a-head to anticipate that the price will be reduced to that of copper, when aluminium, with its conductivity of 200 per cent. that of copper—weight for weight—would, in a large measure, replace the latter metal for mains for electric lighting.

In what I have said nothing has been mentioned about solder. I have here an example of some joints I have had made, which are fairly satisfactory. Strength of joint is secured, but the process of making it requires a good deal of care, on account of the high melting point of the solder and the difficulty of getting it to flow readily. Still it can be done. Messrs. Balfour and Co. have, however, informed me that they have a solder which they propose to bring out shortly which is a great improvement on previous ones. They have brought some examples of work done with it to-night, from which it will be seen that the joints are quite invisible. I have not yet seen any actual joints in the process of being made, but aluminium workers will await further results with interest.

DISCUSSION.

The CHAIRMAN said Mr. Addenbrooke had referred to the probability that where steam engines were employed further experience would lead to improved forms of apparatus, which would admit of heat being applied directly; but it seemed to him that that was very doubtful if the heat were applied to the carbon, which was the reducing agent, because it required more heat to dissociate aluminium than it did to dissociate the products of the reduction, which he held in this case was carbon anhydride. He held the effect was due to the conbined effect of heat, and the dissociating influence of the tearing electric current. But of course this was a matter for discussion. Mr. Addenbrooke had referred to the interesting alloys of aluminium with other metals, and mentioned some facts which were perfectly new to him, especially that nickel and aluminium appeared to disintegrate spontaneously. There were other cases in which alloys behaved in that peculiar way, but they were very rare. He also referred to the alloys of aluminium with the precious metals, and on one of the series he had carefully worked recently, and found that alloys of aluminium and gold possessed certain pecularities which deserved very careful attention. The melting point of gold was 1045° C.; when alloyed with 10 per cent. of aluminium, the melting point fell about 400°, and the alloy was as white as silver; but on adding another 10 per cent., the melting point rose to 20° above that of gold itself and the alloy was a brilliant purple. By adding further quantities of aluminium, the melting point was again reduced until it came to that of aluminium itself, about 650° C. He believed that was the only case known, free from mercury, in which the melting point was higher than that of the least fusible of the constituents, and pointed to the fact that the union of the two metals must be very peculiar indeed.

Mr. S. G. GORDON said the paper was very interesting, and he regretted that he could not add any information, as he had very little opportunity of doing anything with aluminium except seeing the working of it by the Mannesman process. In that way pure aluminium worked very satisfactorily, as was proved by the spinning, and in other ways. The Mannesman Company had made large quantities of aluminium tubes, and found that as long as the metal was pure there was no difficulty in working it, and it would stand repeated rolling, cold, without injury. It had been mentioned that a small quantity of silicon had a great influence on the casting properties of the metal, and that was a line of research which should be followed up, the alloys which had hitherto been made having usually consisted of a fairly large proportion of other metals.

Mr. B. H. BROUGH said he exhibited, at one of his late Cantor Lectures, a series of mine-surveying instruments, made of aluminium, to show its applicability to such purposes. Of course, lightness in this case was of the utmost importance; and anyone who had to carry surveying instruments through the tortuous passages of a mine, or up the steep sides of a mountain, where every additional ounce became a grievous burden, would appreciate that; but, since then, he had had an opportunity of testing the wearing capacity of these instruments, and did not find them altogether satisfactory. He had used a theodolite as an educational instrument, with a class of about thirty students from the School of Mines, and it did not stand the hard usage it was thus exposed to. The screws stripped, and the wear had been very bad, so that it might be safely asserted that aluminium was unsuited for such instruments where an occasional stress had to be borne; for whenever the metal was bent out of shape it seemed almost impossible to restore its original adjustment. He noticed in that week's number of the German mining journal a note about the Neuhausen Aluminium Works, stating that about 54 per cent. of the daily output was consumed by German steel makers, as an addition to molten steel, with a view to obviating the formation of blow-holes. If that were so, it seemed a very important use, and worth mention in the paper. When the members of the Iron and Steel Institute visited the aluminium works at Pittsburgh, they had presented to them, as a souvenir, a little aluminium box, which was one of the prettiest objects he had ever seen. It consisted of a very tasteful design, and showed very clearly how ornamental workmanship in this metal could be made.

Mr. C. W. PARKER (Messrs. Balfour and Co.) said he was not at liberty to go into much detail on this matter, but there was no doubt that this metal was very useful, and his firm had just produced a very reliable solder, the best yet tried, which would be a great service in many ways. One great point about it was that it did not oxidise, and, further, it amalgamated with the metal in the soldering. On one of the pieces he had sent, it had been hammered, and though the metal had bent the joint had not given way. The solder was composed of aluminium and tin; was patented, and instructions for using it would be given to licensees.

Mr. WALTER T. REID said the question of soldering seemed to be of great importance. The composition of one had just been published in *Dingler's Journal*, consisting of 50 cadmium, 20 zinc, and 30 tin. Like other aluminum solders, it was said to be better than the metal itself, and to do everything required of it. He had made some experiments in soldering aluminium, and found that one of the chief points was a flux to cover the joint, as you then had a much better chance of getting a sound joint. Probably the surface of the metal became covered with a thin film of alumina, which prevented the solder flowing. He had also made a few experiments with aluminium as pure as it could be obtained, and had one or two failures to record. It did not answer his expectations, perhaps because they were too high. He found it would not stand sea water, nor even a solution of pure chloride of sodium; the metal was corroded in a very peculiar way, almost as if there were impurities in it, but on cutting out the corroded portions, and testing them, he found they were as pure as the bulk of the metal. Another thing he tried it for was cartridge cases; but he found, when subjected to atmospheric influences, either with black powder, or with some of the nitre compounds which fomed the basis of smokeless powders, it was corroded, not perhaps more than brass, but quite enough to interfere with the strength of the metal. It was well known that the pressure of a very small quantity of sodium had a very deleterious effect on this metal. He should like to ask Mr. Addenbrooke if he had any information as to the action of ordinary liquids used for beverages on aluminium. Some time ago, in the German papers, there was some allusion to an alleged case of poisoning through the action of brandy on the metal of one of these flasks, and although not proved, the statement was sufficient to discourage their use.

Mr. PARKER said the solder he referred to required no flux. There was a specimen on the table which had been in a salt bath for some time, and it was not at all oxidised.

Mr. ADDENBROOKE said he thought the Chairman hardly understood his reference to the use of heat; he did not mean to reduce the metal, but simply to bring the bath to a red heat, which was now done by the current itself. In electric heating you had to put coal under the boiler, turn the water into steam, pass it through the engine, and then operate the dynamo, which was an uneconomical mode of producing heat, though of course you had the heat inside the furnace instead of outside, which might help to balance it. With regard to alloys of aluminium with small quantities of other metals, the work he had done had been with aluminium of over 99 per cent. purity, and in ordinary work he had noticed that the addition of ½ per cent. of other metals did not make much difference; you required one or two per cent. before perceiving any effect; but no doubt by testing the breaking strain accurately, you might find there was a difference. It must be remembered that you had, say, ¾ per cent. of impurity to start with, so that it was impossible to say what was due to the added metal, and what to the impurity. Perfectly pure aluminium had not been furnished, and he did not think its electrical resistance had yet been accurately determined. It was tested some time ago, when the metal might have had from 2 to 3 per cent. of impurities, and they knew what a great difference a slight impurity made in the resistance of copper.

The figure usually given was about 56 per cent., but in some samples he had measured he had found 58 per cent. of copper. The mention of the survey instrument introduced a point on which some stress ought to be laid. People talked about aluminium as if it were something quite definite, whereas, for all these instruments, an alloy of some kind ought to be used. If they were made of a suitable alloy he would not say they would have lasted as well as brass, but they would certainly wear better than ordinary aluminium even with a little silicon in it. With regard to the addition of aluminium to steel and bronze, he did intend to refer to it, as it was exceedingly interesting, but he thought the scope of the paper was large enough without going into it. One gentleman said he found he could solder aluminium better with the use of a flux, but the usual methods were without any flux, which was generally found to be a nuisance. He had noticed some discrepancies with regard to the action of salt, but fancied they might be traced to the fact of a rather impure sheet being rolled cold. If that were the case, it disintegrated in laminæ, and the salt got underneath and forced out the metal, forming a sort of exfoliated surface. With a really pure metal, well rolled, there was very little action indeed. He had put some in salt water with various organic matters and left it for weeks, and it was very little acted on. He also put some in a bottle of cider and left it uncorked for many weeks, and there was very little action. Most of the soldering must be done with a blowpipe, but an aluminium bit to work over the surface was a useful addition. The difficulty was that the solder did not flow well. You had to heat the metal up to a certain point, when it was just beginning to disintegrate, apparently before the solder began to take: first it went to a pasty state, and then, on a rise in temperature, it began to flow. He hoped the new solder spoken of would be more successful. The melting point of the solders he had used was nearly that of aluminium, and it was almost impossible to do fine work with it without many failures; you were so apt to melt the sheets. There was a method of autogenous soldering by bringing the two surfaces together, and pouring metal on to them until the edges melted and united together, and then cleaning the metal off; it could also be done by means of electricity, but he had not had much experience of these.

The CHAIRMAN then proposed a vote of thanks to Mr. Addenbrooke, which was carried unanimously.

Miscellaneous.

PRESERVED GINGER.

The marked difference between the Chinese preserved ginger and that from the West Indies has been the subject of inquiry by the authorities at Kew as to whether both articles are really the product of the true ginger plant (*Zingiber officinale*). The evidence—other than that of the root—pointed at one time to the fact that the same plant yielded both commercial articles; subsequent materials, however, indicated that Chinese preserved ginger was the rhizome of *Alpinia Galanga*, while that from the West Indies was from the original *Zingiber officinale*. It would seem, however, that still further research into the matter has restored the origin of Chinese ginger to the same plant as the West Indian.

Of the practice of ginger cultivation and the process of preserving but little is generally known. As ginger is, however, an important article of commerce, both in its dried and preserved conditions, the following notes on the subject from the December number of the *Bulletin of the Botanical Department of Jamaica* may be of interest. The most suitable soil for ginger culture is said to be a well drained clayey loam. The land should be well dug and cleared of weeds. Small pieces or protuberances of the root, one or two inches long, are planted during March or April, four inches deep and nine to twelve inches apart. It is well to cover the land with a moulding of dead leaves, weeds, straw, or litter mixed with manure. In a few months the whole ground will be covered. The flowers appear in September. When the stalks wither in the following January or February, it is time to dig up the roots. When the tubers have arrived at maturity and have put forth stems they are fibrous, but before this takes place, while they are still succulent and the young stalks are not more than five or six inches long, they should be taken up for preserving. Ginger is an exhaustive crop on the soil, and should not be planted in the same ground two consecutive years. The yield per acre is said to be 4,000 lbs. and upwards.

Black ginger of commerce is prepared by washing the root in water, boiling for a quarter of an hour. and then drying in the sun. White ginger, a much superior article, is prepared from the best and soundest roots, by scraping off the outer dark coloured part, and then carefully drying, without boiling.

Preserved ginger is made from the young tubers, which are scalded, washed in cold water, and then peeled; the roots are then covered with a weak syrup, and left for two days. The syrup is then poured off and replaced by a stronger syrup, and this is repeated two or three times until the syrup is thick and the ginger bright and nearly transparent. The following is given as the best method of preparing preserved ginger. Pour boiling water on your ginger, and let it steep for a day and a night, then peel and pare away all discoloured and hard parts Boil a syrup of 1 lb. lump sugar to six pints of water (this is for 12 lbs. of ginger). Put your ginger into a stone jar and pour the thin boiling syrup on it, let this stand for a week or ten days, then draw off the syrup and throw another, exactly the same as the

last, again boiling, over your ginger; let this stand for another week, then throw off the second syrup and drain the ginger well on a hair sieve, return it to the jar, and pour over it the final syrup, made as follows:—12 lbs. loaf sugar to 12 pints boiling water; stir till the sugar is dissolved, for fear it should settle and burn, then boil till it is as thick as good honey, and drops slowly from a silver spoon; now pour boiling water over the ginger and let it stand till cold, when you can put it into the bottles or jars in which it is to remain. Put in the pieces of ginger, first, as close as they will pack, then fill right up to the cork to leave no room for air. The corks should be new and good, not old ones that have been pierced by corkscrews.

Since the above was written, some instructions, similar to the foregoing, on the cultivation and curing of Jamaica ginger, printed for distribution in Trinidad, have appeared in the *Kew Bulletin* for April last, together with a notice of a sample of ginger recently received at Kew from Fiji, where it had been grown and cured, and the reports from experts in London were such as to induce further efforts in Fiji. It is described as "remarkable for its exceedingly fine aroma and peculiar pleasant taste, recalling that of lemon."

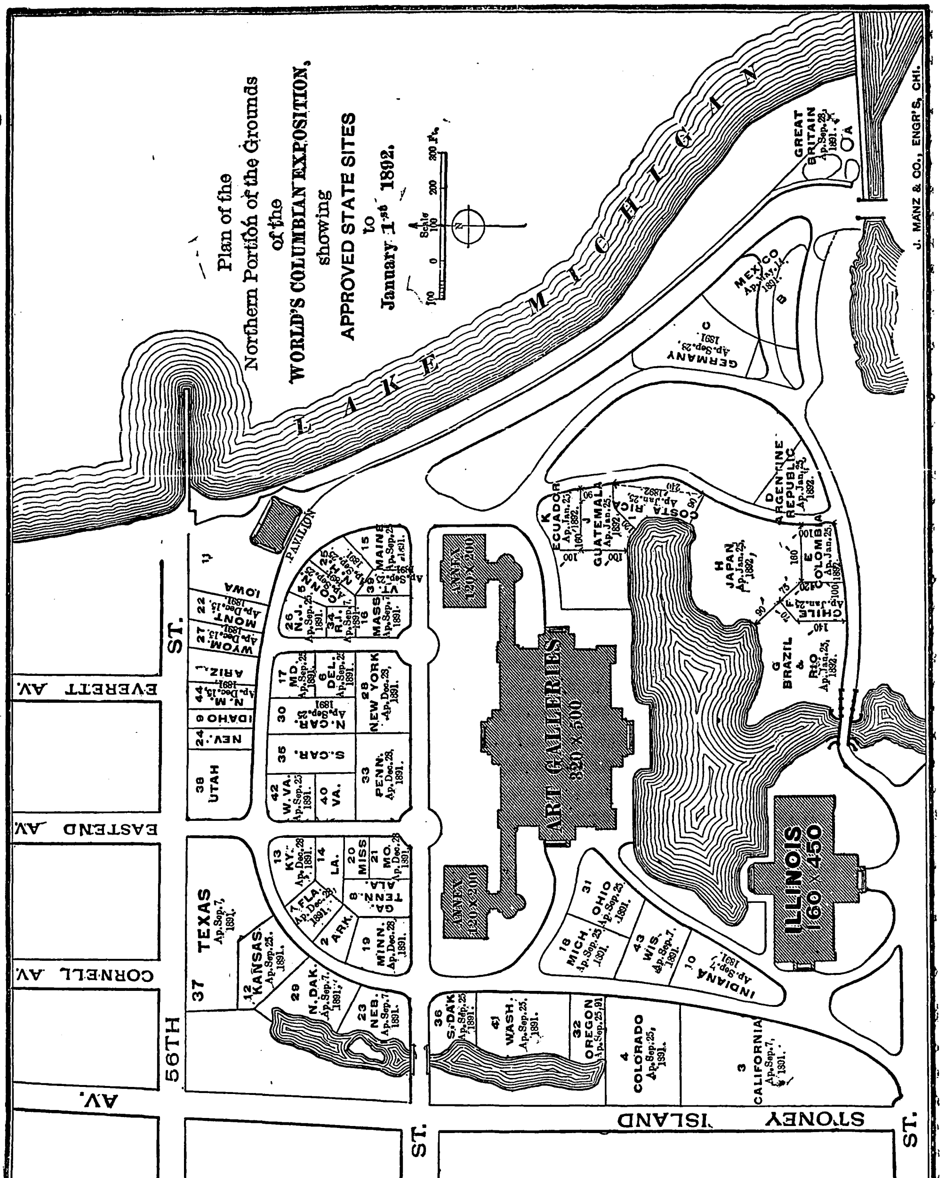
On the subject of the cost of preserving ginger and some of the Jamaica fruits for the English market, a correspondent of the Botanical Department, who, it is said, has been most successful in the operation, writes thus:—"The price charged for all Jamaica preserves is excessive, and defeats its own ends. For instance, preserved ginger, say one shilling for the young ginger, to make 12 lbs., one shilling for the first syrup, and for second, allowing sixpence per lb. for lump preserve sugar, the cost of this being 19s. 9d. per cwt. in England; sixpence for the last syrup. In fact, 6d. per lb. would more than cover the cost of production, apart from labour, and the labour is certainly not greater than that bestowed on most English preserves sold at from 4d. to 6d. per lb. The usual statement as to the cost of the manufacture of ginger is as follows:—It takes 3 lbs. of lump sugar, at 9d. per lb., to make 1 lb. of ginger. Ginger has to be so much pared away, that a shillingsworth makes only a few lbs. The labour is very great, and the profit very small. All these are, I maintain, false statements, and have stood in the way of anything like a large and remunerative trade in Jamaica preserves being established. Fortnum and Mason give it as their opinion that the bar to such a trade is, that Jamaica preserve cannot be sold in London in one shilling glass jars; the British public will buy a small jar of any foreign delicacy at 1s., when they would refuse a larger one at 1s. 6d. This seems a hint worth taking. We ought to popularise our beautiful and delicious preserves by selling them at a small profit, which experience has found again and again results in a much larger gain in the long run. For instance, can any Jamaican assert that guava jelly costs more to make than the best strawberry jam, which is sold in highly ornamental glass jars at 6d. per pound anywhere in England. The guavas grow wild here, and can be had in profusion for the picking. Jamaican vacuum pan sugar makes the jelly in perfection, and can be bought by the bunch at about 2½d. per lb., if I am not mistaken; and, having made both strawberry jam and guava jelly myself, I can confidently assert that the latter is not half the trouble of the former. My sole object in writing this is, that I believe Jamaica is throwing away a large and lucrative trade, which might be hers, if she would remember her own wise saw, "Greedy choke puppy."

These plain words may draw attention to this important subject, not only in the West Indies, but in other tropical countries.

TINPLATE TRADE WITH AMERICA.

Machinery forms an exception to the list of manufactures—rather a long one—in which so far this year but little has been done with the United States. That list includes various metals and metal wares, and also steam-engines, but in general machinery we have done better. From the Board of Trade Returns to hand since our last issue, giving statistics for the first quarter of the year, we notice that the value of machinery and millwork in the first quarters of the three past years rose from £151,994 in 1890, to £224,715 in 1891; and to £236,195 in 1892. To some extent confirmatory of the better business which such figures indicate, is the quarterly return of the United States Consul for Birmingham, also issued since we last went to press. This shows an enormous expansion in the trade in cycles and cycle materials, the advance (in dollars) being indeed as great as from $152,197 last year to $292,911 this year. Cycle exports from the Wolverhampton agency rose also from 5,262 to 14,014. Bedsteads from Birmingham rose from 29,628 to 47,689; and anvils from 19,672 to 21,545. Hardware and steel and iron are down on the year, but the advances above indicated are gratifying, and go to show that, notwithstanding the increasingly severe Protectionist policy of our Transatlantic friends, they are still unable to do without the assistance of British machinery manufacturers. As to the tinplate business with the States this, of course, has fallen off on the year, the quantity we sent being 64,611, or about 34,000 tons less than in the corresponding quarter of 1891. Yet the former quantity may be looked upon as a fair, normal average under the altered conditions brought about by the M'Kinley Tariff, as the average for the three years preceeding was equal to 81,500 tons quarterly. Satisfaction is expressed that the Ways and Means Committee of the United States House of Representatives have reported in favour of the Bill reducing the duty on

tinplates from $2\frac{1}{2}$ cents to 1 cent per pound, and making tinplates duty free after October 1, 1894. The measure is, however, threatened with severe opposition in the Senate, and it is doubtful whether it will become law.—*Implement and Machinery Review.*



CHICAGO EXHIBITION.

The above illustration shows the northern portion of Jackson-park with the allotments made for the buildings of the various states, and the additions which are being made to the Art Gallery.

The plan also shows the positions which have been granted to various foreign countries for the erection of special buildings. The position of the building, which will be erected for the British headquarters, is indicated in the right-hand lower corner of the plan.

Correspondence.

BRADFORD CORPORATION ELECTRICITY SUPPLY.

As I had not an opportunity of replying to one or two statements made by the Chairman, Mr. W. H. Preece, at the termination of the discussion on the above paper last week, may I request the insertion, in the next issue of the *Journal*, of the following remarks:—

1. *As to estimating the output of an electricity station in terms of the number of lamps fixed, of eight c.p. each.* Instead of this being, as the Chairman stated, "the very pith of the question," it is (as named in my remarks at the beginning of the discussion) a very delusive one, often misleading, and one which is purely theoretical, and liable to considerable errors. It may be only part of the output, which (with a "continuous" current at least) may be utilised for lighting purposes; and even that is liable to use in different proportions in several kinds of lamps, which again may vary according to their make. Moreover it is well known how difficult it is to ascertain the actual number of lamps fixed· With a Corporation, who are forbidden to have anything to do with the supply, or with the fitting up of the lamps of the consumers, it becomes, therefore, little more than matter of guesswork, as to how many lamps are actually fixed.

But the principal argument against this mode of estimating the supply is, that it does *not* comply with the terms in which, in the various Parliamentary Electric Lighting Provisional Orders, it is enacted, that the supply is to be estimated. In the earlier Orders of 1883 (of which that of Bradford is one), it is termed a supply of electricity—and each customer is to state, in his application, the maximum rate of current required to be supplied. In the later Orders, 1890, and after, the supply is termed one of electrical energy; and the application must be for the maximum rate at which the electrical power is to be supplied. In all cases the reply should be in "ampères," and certainly not in lamps; for the Legislature certainly contemplated the electrical supply in its fullest application, and not merely as limited to lighting purposes.

2nd. *As to the relative value, in their respective applications, of "continuous" and of "alternating" currents.* After stating, that the Frankfort Exhibition had shown, that the latter form of current was capable of all the applications of the former class, the Chairman adds, "it only required the introduction of a transformer to convert the alternating current into a continuous form." Surely this is very suggestive of the famous discussion on the respective merits of "Black" and of "White" (colours). "But black isn't white," says A; "Yes it is," replies B, "provided you paint it white."

It is not, however, necessary to wait until the year 1891, and the Frankfort Exhibition, to behold the wondrous transformation. For, in 1853, Mr. F. H. Holmes (the designer, subsequently, of the "Holmes" machine for our Trinity House), in Paris, under the auspices of the Société Générale de l'Electricité, transformed, by means of a complicated commutator, the output of several large alternating machines, of eight magnets each, into a continuous-direction current.

One, if nor more, of these machines has been working ever since, under the name of the "Alliance" machine, at the lighthouse of La Hève, near Hâvre—the commutator, however, has been dispensed with.

It is singular, too, how many times, of late years, our expectations have been raised (apparently in vain, as far as actual industrial application at least is concerned) respecting the more extended application of the "alternating" current; and more especially as regards the transmission of motive power.

In the interests of electrical science, and of its applications, it is sincerely to be hoped that these expectations may soon be realised; and by no one would these realisations be more warmly welcomed than by the writer.

JAMES N. SHOOLBRED.

General Notes.

CHICAGO EXHIBITION.—M. Krantz, a member of the Chamber of Deputies, has been appointed French Commissioner-General to the World's Fair at Chicago.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 18.—Captain W. de W. ABNEY, C.B., F.R.S., "Colour Blindness." R. BRUDENELL CARTER, F.R.C.S., will preside.

MAY 25.—F. E. IVES, "Researches in Photochromy."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MAY 19.—JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India, "The Administration of the Imperial Census of 1891 in India." Sir CHARLES BERNARD, K.C.S.I., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade." The Hon. JAMES MUNRO, Agent-General for Victoria, will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 17.—WILLIAM SIMPSON, R.I., "Mud as a Material for Architecture in Persia and the East." General ROBERT MACLAGAN will preside.

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware."

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

Professor PERCY F. FRANKLAND, Ph.D., B.Sc., F.R.S., "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." Four Lectures.

LECTURE III.—MAY 16.—Practical results of recent investigations—Hansen—Alcoholic fermentation with and without oxygen—Carbohydrates fermentable by yeasts—Artificial sugars in their relationship to yeasts—Fermentations of milk.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Percy F. Frankland, "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." (Lecture III.)

Institute of Chemistry, Burlington-house, W., 3 p.m. Conference on "The Present Regulations with respect to the Admission of Fellows and Associates to the Institute."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. H. Preece, "The Art of Internal Illumination of Buildings by Electricity."

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Sir W. Dawson and Rev. J. Mells, "Primitive Man."

TUESDAY, MAY 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. William Simpson, "Mud, a Material for Architecture in Persia and the East."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. E. Ives, "Photography in the Colours of Nature." (Lecture II.)

Civil Engineers, 25, Great George street, S.W., 8 p.m. 1. Discussion on Mr. A. P. Trotter's paper, "The Distribution and Measurement of Illumination." 2. Professor W. C. Roberts-Austen, "The Measurement of High Temperatures."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. J. S. Jeans, "The Recent Movement of Labour in Different Countries in Reference to Wages, Hours of Work, and Efficiency."

Pathological, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

Zoological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain W. De W. Abney, "Colour Blindness."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. M. Whipple, "Results of a comparison of Richard Anémo-Cinémographe with the standard Beckley Anemograph at the Kew Observatory." 2. Mr. E. J. Lowe, "Rain-drops." 3. Mr. W. B. Tripp, "Levels of the River Vaal at Kimberley, South Africa, with remarks on the Rainfall of the Watershed."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. P. T. Lewis, "The Organs of Oviposition in certain Cattle Ticks." 2. Mr. E. M. Nelson, "The Penetrating Power of the Microscope" and "The Rings and Brushes of Crystals."

Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

United Service Institution, Whitehall-yard, S.W., 3 p.m. Discussion on the subject of the Naval Essays, "Maritime supremacy being essential for the general protection of the British Empire and its Commerce, to what extent, if any, should our Naval Force be supplemented by fixed defences at home and abroad, and to whom should they be confided?"

THURSDAY, MAY 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Jervoise Athelstane Baines, "The Administration of the Imperial Census of 1891 in India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. H. Perkin, "Magnetic Rotation of some Acetyl Derivatives." 2. Mr. A. R. Ling, "Studies on Isomeric Changes; No. IV., Halogen Derivatives of Quinine (Part I.)." 3. Messrs. E. R. Moritz and T. A. Glendinning, "Note on Diastalic Action." 4. Dr. Kipping, "Formation of the Hydro-Carbon $C_{18}H_{12}$ from Phenylpropionic Acid."

Encouragement of Fine Arts, 9, Conduit street, W., 8 p.m. Mr. Philip H. Newman, "The Chronology of Costume," Part II. (Mediæval and Modern Times).

Royal Institution, Albemarle-street, W., 3 p.m. Professor Dewar, "The Chemistry of Gases." (Lecture IV.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 11, Chandos-street, W., 8½ p.m. Prof. Montagu Burrows, "Publication of the Gascon Rolls by the English and French Governments."

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. H. P. Robinson, "A Note on Feeding, and our Debt to Science."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MAY 20...United Service Club, Whitehall-yard, S.W., 5 p.m. Major E. Satterthwaite, "The late War Game in the Open."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. J. Wilson Swan, "Electro-Metallurgy."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. R. Inwards, "An Instrument for drawing Parabolas." 2. Mr. F. H. Nalder, "Some Electrical Instruments." 3. Messrs. E. Edser and H. Stansfield, "An Instrumeut for measuring Magnetic Fields."

SATURDAY, MAY 21...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. Dannreuther, "J. S. Bach's Chamber Music" (Lecture IV.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,061. Vol. XL.

FRIDAY, MAY 20, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 29th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal.*

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examinations will be held by Sir John Stainer, Mus.Doc., and W. G. McNaught, A.R.A.M., joint Examiners, at the House of the Society of Arts, and will commence on Thursday, 9th June. No names can be received after Monday, 23rd May.

Full particulars can be obtained on application to the Secretary.

CANTOR LECTURES.

On Monday evening, 16th inst., Professor Percy F. Frankland, Ph.D., F.R.S., delivered the third lecture of the course on "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries,"

The lectures will be published in the *Journal* during the autumn recess.

FOTHERGILL PRIZE.

The following Report of the Committee on the award of the Fothergill Prize has been received and approved by the Council.

List of the Committee. — The Attorney-General M.P., Chairman of the Council, Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Thomas Edward Collcutt, F.R.I.B.A., Major-General J. F. D. Donnelly, C.B., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., William Henry Preece, F.R.S., Edward Terry, Sir Henry Trueman Wood, Secretary.

In answer to the offer made under the terms of the Fothergill trust, of a Society of Arts Gold Medal or £20, for "the best Invention having for its object the Prevention or Extinction of Fires in Theatres or other places of amusement," eighteen competitors submitted designs, models, essays, samples, or suggestions. The Committee regret that, after a careful examination of the various proposals, they cannot find any one which they consider of sufficient merit, and coming sufficiently within the terms of the offer, to justify them in recommending it for the distinction of a Society of Arts Medal. They regret this the more because, on the last occasion when the medal was offered, in 1884, for a similar object, the resulting competition was equally unsuccessful.

On that occasion, Mr. E. A. Woodrow submitted an essay on the subject, which was published in the *Journal of the Society of Arts* for April 18, 1884. The same gentleman has adopted a similar course on the present occasion, and has sent in an essay, which the Committee consider possesses considerable merit as a *resumé* of the points to which experience has shown that attention should principally be directed in theatre construction, so far as regards the safety of the audience. They do not feel that they are empowered to make any award for an essay, but they recommend that Mr. Woodrow's contribution should be published in the Society's *Journal,* as they believe that it contains information of public value.

Mr. S. B. Wilkins, Fire-Master of Edinburgh, submitted a very elaborate model of a theatre, fitted up with appliances for preventing and extinguishing fire. Many of the appliances employed have been a considerable time in use; some even have, in the opinion of the Committee, been improved upon; but the proposed arrangements are very complete, and have evidently been most carefully thought out. A theatre, fitted up on the plan illustrated by Mr. Wilkins's model,

would be in advance of any but those of the most recent and advanced construction.

Mr. Shean submitted an ingenious combination of a ladder with fire-hose and jet, and fitted with a specially shaped axe for cutting away burning scenery. The Committee hesitate to express any opinion on this device, and they were not informed as to its having been practically tested. It is at least an open question, with regard to the value of the axe, whether it is often advisable to cut down the burning material, and whether, when this has to be done, the work cannot better be carried out from the flies.

Messrs. Messer and Thorpe submitted a very handy and simple method of fitting buckets, one within the other, inside a reservoir or cistern. As the first bucket is lifted out, full of water, the second, within which the first was fitted, instantly fills and can be lifted out, and so on throughout the series. A large number of buckets can thus be stored with great economy of space. The cistern may merely contain sufficient water to fill all the buckets, or may be supplied by a ball-tap.

Messrs. Blanchard, and Messrs. Mark Fawcett and Co., showed samples of their methods of fire-proof construction. The Committee have no hesitation in commending both, but they do not consider that generally applicable methods of construction, not specially intended for theatres, come within the terms of the offer.

Messrs. Davis and the Cyanite Company submitted samples of fireproofing solutions and paints. The value of such materials, and the limits within which they are applicable, are now well known. It is to be desired that they were more extensively used than they probably are. The Committee cannot see that those submitted present sufficient novelty to justify them in recommending an award to it. The Committee may refer to the account of these materials contained in the *Journal* of May 25, 1883, as an appendix to the Report of the Committee on Prevention of Fires in Theatres.

Messrs. Warbey sent some "sprinklers;" and some other examples were also submitted of this now well-known class of appliance by Mr. S. B. Wilkins.

The other proposals submitted to the Committee do not, in their opinion, call for any remark.

The Committee, in deciding that they could not recommend any award of the Society's medal, considered that no good purpose would be served by making an award to any invention which was not of decided novelty, importance, and value. The competition was not successful in bringing out any such invention, and, in reporting this to the Council, the Committee recommend them to consider whether some course other than the offer of a prize medal might be adopted, whereby the excellent intentions of the founder of the fund might be likely to be more usefully carried out.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 18th inst. Present: The Attorney-General, M.P., Q.C., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., M.P., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Francis Cobb, General J. F. D. Donnelly, C.B., Sir Henry Doulton, Francis Elgar, LL.D., Sir Douglas Galton, K.C B., D.C.L., F.R.S., Thomas Hawksley, F.R.S., C. Malcolm Kennedy, C.B, G. Matthey, F.R.S., J. Fletcher Moulton, Q.C., F.R.S., Prof. W. C. Roberts-Austen, C.B., F.R.S., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, M.A., as Secretary.

PHOTOGRAPHIC COMMITTEE.

The first meeting of the Photographic Committee was held on Friday, 13th instant. Present: B. Francis Cobb (Chairman of the Committee), George Davison, Colonel Joseph Gale, H. P. Robinson, and Sir Henry Trueman Wood, Secretary of the Royal Commission.

APPLICATIONS FOR SPACE.

Intending exhibitors are reminded that applications can only be received up to Saturday, 21st May. Any applications received after that date will be filed, in case of any space becoming hereafter available, but will not be included in the allotment.

All applications must be made upon forms to be obtained from the Secretary of the Commission at their offices, Society of Arts, John-

street, Adelphi, London, W.C. They must be sent in, properly filled up, and addressed to the Secretary, as above.

Proceedings of the Society.

TEMPORARY ALTERATION OF BYE-LAWS.

In accordance with the notice duly given, a General Meeting of the members was held at the Society's House on Wednesday, 18th inst., the ATTORNEY-GENERAL, Q.C., M.P., in the chair.

The SECRETARY read the notice convening the meeting as follows :—

The Council hereby convene a General Meeting of the members to be held at the Society's House, in the Adelphi, on Wednesday, the 18th May, 1892, at 4 o'clock in the afternoon, for the purpose of considering, and if thought desirable of passing, the following resolutions :—

1. That in accordance with the proposal from the Council, the Bye-laws be altered and varied in such manner that the Council shall be empowered, during the years 1892 and 1893, to appoint not more than six members to be Vice-Presidents or other Members of the Council in addition to those appointed under Bye-laws 79 and 84, and that the Council be empowered to determine the period or respective periods that members so appointed shall continue in office, not being later than the end of the Session commencing 1893, and that all Bye-laws which are inconsistent with such appointment and determination be suspended or varied.
2. That Bye-laws 8, 9, and 10 be suspended during the Sessions 1892-3 and 1893-4.

Bye-Laws 8, 9, *and* 10.

8. The Chairman of the Council shall be chosen from those Members of the Council who are of one year's standing at least.

9. The Chairman of the Council, after two years' service, shall not be re-eligible to the office for at least one year.

10. The Chairman of the Council shall deliver an address to the Society at its Ordinary Meeting after his election.

The CHAIRMAN said—Gentlemen, I will just say a word or two in order to explain to the members present, who have not been in communication with the Council before, the object of the proposed alteration of Bye-laws. You are aware that the Society of Arts is governed by a charter, and by certain regulations under which the members of the Council must go out of office after a certain number of years' service, either as Members of Council or as Vice-Presidents. You are also aware that in the summer of last year Her Majesty was graciously pleased to appoint the Council of the Society of Arts the Commission for the Chicago Exhibition. Work of an important character has been thrown on the Council, and I think the members of the Society of Arts have approved the duties and conditions imposed on the Society by the gracious act of Her Majesty. Now, there are upon the Council at present some two or three gentlemen who have great experience in Exhibition matters, who would, by the ordinary rules of the Society, be unable to serve during the coming yea[illegible] and I am sure th[illegible]the members would regre[illegible]the loss of coun[illegible]rs so particularly qualified [illegible]o assist and guid[illegible] Council on these mat[illegible]s. Therefore, whi[illegible] should propose for elec[illegible]on, in the ordinary [illegible] gentlemen to fill the o[illegible]e of Vice-President[illegible]d Members of Council in accordance with the Bye-laws, it has seemed fit to the Council, after considering the matter in committee, to recommend that there s[illegible] be for two years this alte[illegible]on of the Bye-laws, [illegible] that six members of the Society should be appo[illegible] Vice-Presidents or Members of Council, in additi[illegible] those who would be appointed under the Bye-la[illegible] they stand. That would enable the Council to ap[illegible] any gentleman whom they consider specially qualified to assist the Council. The other Bye-laws are minor matters, dealing with the actual duties to be performed by those who have had to serve on the Council, and by the Chairman. They are not of much importance, and I do not apprehend that anyone will require further explanation as to them. I am sure the members will think the Council have been considering the interests of the Society in proposing these alterations; and, with these observations, I beg to move the alteration of the Bye-laws. If any gentleman has any question to ask, I shall be happy to answer him.

Sir FREDERICK BRAMWELL—As this is a proposition emanating from the Council, I think, as Vice-Chairman, I should second it. I will not take up your time by adding any observations to those made by Sir Richard Webster, as I am sure he has fully explained the intention and object of the proposed alteration.

The resolution was put and carried unanimously. The meeting was then closed.

APPLIED ART SECTION.

Tuesday, May 17, 1892; General ROBERT MACLAGAN in the chair. The paper read was, "Mud, a Material for Architecture in Persia and the East," by WILLIAM SIMPSON, R.I.

The paper and report of the discussion will be printed in an early number of the *Journal*.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 18, 1892; R. BRUDENELL CARTER, F.R.C.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Cassavetti, John, The Cedars, Torquay, and Exeter College, Oxford.
Corsan, John Richard, 5[illegible], Gray's-inn-road, W.C.
Elli[illegible], John, Derwent-h[illegible]e, Upper Villiers-street, [illegible]olverhampton.
Ellwood, Thomas Ashcroft, 13, Cavendish-road, Harringay, N.
Little, Thomas David, Public Works Department, Bombay, India.
[illegible], William Graham, [illegible], Cannon-street, E.C.
[illegible]hall, William Bayley, Richmond-hill, Birming[illegible]m.
[illegible]te, Henry, 80, London-road, Carlisle.
[illegible]rtzburg, John Henry, care of Messrs. Greenwood and Batley, Albion Works, Leeds, and 2, De Grey-road, Leeds.

The following candidates were balloted for and duly elected members of the Society:—

Bamber, M. Kelway, Seleng, Jorehat, Upper Assam, India.
Griffith, Frank, Prujean-square, Old Bailey, E.C.
Grimes, Arthur John Luna, Telegraph Department, Bombay, India.
O'Connor, John, M.P., House of Commons, S.W.
Townend, James Hamilton, Haberdashers'-hall, Gresham-street, E.C.

The CHAIRMAN announced, with much regret, that the death of Capt. Abney's father had compelled him to be absent, but they were greatly indebted to Capt. Abney's colleague at South Kensington, General Festing, for coming forward, not only to read the paper, but also to supervise the conduct of the very beautiful experiments by which the paper would be illustrated; these were the result of Captain Abney's recent work, with which General Festing had been intimately associated.

The paper read was—

COLOUR BLINDNESS.

BY CAPTAIN W. DE W. ABNEY, C.B., F.R.S.

I do not wish to-night to bring forward any debateable points on the subject of the theory of vision. What I want to do is to deal with facts, and facts alone; at the same time illustrating some of these facts experimentally by the methods which General Festing and myself have initiated and used in the investigations which we have described in papers to the Royal Society from time to time. A committee appointed by the Council of the Royal Society has been investigating the subject of the best tests to employ for detecting colour blindness, and in the capacity of secretary to that committee I have had unusual opportunities of examining cases by spectral methods, and have found that the interest in colour vision increases the more it is investigated in a scientific spirit.

The early history of the discovery of the existence of colour blindness I need not enter into. History has a charm for many, but I confess that ancient history, *quâ* history alone, has very little charm for me, and I prefer to deal with the present rather than with the past. I shall, therefore, leave to the lover of history a page which he can fill up for himself in this paper, merely mentioning the fact that Daltonism was a name given to colour blindness from Dalton, the chemist, and that in France, even to the present time, this kind of abnormal vision is still characterised by this word.

Colour blindness we may divide into two classes—1st, congenital, and 2nd, that induced by disease; and we shall see that these differ very widely in character, the latter, indeed, being in some respects a greater defect than the former.

Congenital colour blindness is very varied in its phases, and I propose to describe these by referring to the spectrum. When a person possessing normal vision looks at the spectrum, he will tell you that he sees six or seven colours —red, orange, yellow, green, green-blue, blue, and violet; and these all appear to occupy well defined spaces in the spectrum. Now, about 96 per cent. of males see these colours in the same relative positions, and in the same fairly defined limits. But, if we take the remaining 4 per cent. of males, or perhaps a rather greater percentage, we shall find that they describe the spectrum in a totally different manner. If by some means we are able to show any part of the

spectrum alone, they will describe the colours very differently to that in which they would be described by those whose perception of colour is normal. Some will see no colour and no light in the part of the spectrum which lies near the limit of the red. They will call a bright red green, or yellow, or sometimes red, and they will also be liable to call a green the same, but what their sensation is can be readily judged by a little artifice. Before describing this artifice, I will show you a diagram of the Young-Helmholtz theory of colour vision, which I shall use, not as accepting it in its entirety, but as explanatory of a good deal. It will be seen, on reference to the diagram, that there are supposed to be only three sensations of colour, one which gives the impression of violet, another of green, and another of red. The stimulation of each of these colour sensations is effected by rays occupying a long range of the spectrum; but at the extreme ends of the spectrum only one sensation is at all excited. For a sensation of the intermediate colours, two, or all three, of the sensations have to be stimulated. Thus in the green, the red and the violet and green sensations are excited, but the green more than the other two, and, as in the diagram, an equal stimulation of all three sensations means the perception of white light, we have where the red and violet perception curves cut one another more than sufficient green sensation excited to produce white alone. We have, therefore, a surplus of green sensation excited over and above that necessary for the production of white. The green of the spectrum is, therefore, to the normal eye, the pure green produced by the green sensation diluted with white light. In the same way we might deduce the sensations produced by other colours; thus orange is a slight stimulation of the green sensation with more of the red sensation, but, as before said, at only the extreme limits of the spectrum is one sensation excited. In fact, it may be said that no normal-eyed person has ever felt a pure green sensation, though he has felt a pure red and a pure violet sensation. Setting this aside for the moment, we may prognosticate what would happen (supposing of course the Young-Helmholtz theory were true) if any one or two of the three sensations were absent. Evidently if the red sensation were absent, the eye would see a pure green sensation at one end of the spectrum and a pure violet at the other, but intermediately they would see mixtures of green and violet. Where the curves of these two remaining sensations cut one another, the colour then would be of the same hue as the colour of white light; for it must be remembered that each of the curves in the diagram is supposed to have equal areas. This being so, it is evident that, as the curves are of equal height, were they cut, the colour at the point of the spectrum is the same to them as white. Further, it will be seen that this white or neutral colour is mixed up with both the green and violet sensations more or less, except at the extreme ends of the spectrum; and that where the extreme red is, no light should be perceived; but in the orange and scarlet the sensation will be nearly pure green. This then is a type of red blindness. Now, having taken this view of the matter, we may anticipaté that the colour-blind man, who answers to this description, can readily be deceived as to what is the true colour by an artifice. As a rule, the colour-blind are very acute in the perception of differences of dilution of colour with their neutral colour, and of the brightness of the colour itself. If, then, we have a means of mixing with, what to the normal eye is (say) orange, a variable proportion of white, which, remember, is also to him his neutral colour, he will be unable to distinguish it from a green. To effect this, we can use the apparatus I have described before in these rooms, superposing a white patch of light over a patch of any spectrum colour I may wish to use. If, therefore, we in practice dilute an orange patch of light with white, there will be no difference in hue with some green, and although the colour-blind may have been educated to call the spectrum colours by their right name under ordinary conditions, yet through the more or less dilution with neutral colour—*i.e.*, this mixture of white light with it—will at once destroy what may be termed the landmarks he has set up in his mind, and he will confound them with others. From the diagram it will be evident that, if the patch were orange, it will, when diluted with white light, be to him the same as the yellowish-green of the spectrum. As before indicated, he will see a neutral coloured space in the spectrum, and, on one side of this neutral colour, blue, and on the other what the normal-eyed call green, both mixed more or less with this neutral colour as the neutral point is approached.

If the green sensation be absent from an eye, according to this provisionally accepted theory, then there would still be a neutral point

in the spectrum which, for the same reasons as those given before, the colour-blind of this type would mistake for what to him is white; but the spectrum would remain of the same length as it is to the normal eye. This is a case of green colour-blindness. By mixing a red with white, the colour-blind would be totally unable to distinguish between red and green, as in the other case. Both cases are not uncommon, and it has been remarked that these last often call the colours they see on one side of the neutral point in the spectrum "yellow," whilst on the other they correctly call it blue. The reason of their colour nomenclature is not far to seek. They get their ideas of colour from normal-eyed persons, and fix upon the brightest objects as their standard, and these are yellows. A look at the diagram shows that to them the yellow is a bright and almost pure sensation, though it is probably red.

Another case of colour-blindness is when the violet sensation of this theory is absent, and I have only met with one example of it at all. The spectrum appeared to end about G, but by subsequent examination he was able to trace it as having a very feeble existence for some distance beyond. This colour-blind person also had a point in the spectrum which he mistook for white. This was in the yellow, a point where, according to the theory, it ought to exist.

Two other cases, which are of special interest, have now to be described. They are cases where one sensation alone was present; every colour was the same to them as white: blue, yellow, red, green, were all grey—that is, degraded white—and it was immaterial to them what colour they were asked to match; by sufficiently reducing the intensity of those which to them were the brightest, they were able to describe them as exact matches with the feebler colours. Thus a blue and a red would be made to match exactly in intensity and, of course, in colour. By matching the various points of the spectrum with different shades of grey, by the method which I have twice described in this room, the relative brightness of the different colours of the spectrum as felt by them was readily measured, and is that shown in the diagram, with a maximum at E in the green.

Now all light, if made feeble enough, can be extinguished to the eye, although it is really present; and measures have been made of the extinction of every colour of the spectrum. It was found that when the D (sodium) light of the spectrum had the same illuminating value as an amyl lamp (AL), a screen placed one foot off the source of illumination was just not seen when it was reduced to 350-10,000,000th of an AL, whereas the E light of the unaltered spectrum had to be reduced to 65-10,000,000th. The F light had to be reduced to 150-10,000,000th, and the C light to 11,000-10,000,000th, as will be seen by the following Table. If we make the light of the

	Extinction of light in 10 Millionths.
B	50,000
C	11,000
D	350
E	65
F	150
G	3,000

different parts of the spectrum each equal to one AL, it will be found that the extinctions at the violet end and at the extreme red are uniform, the violet end requiring the reduction 150-100,000,000th AL to render the screen invisible. This indicates that only one sensation is extinguished at the violet end and one at the red end — (this agrees with the Young-Helmholtz theory, it will be remembered) — but that the red sensation is 125 times more easy to extinguish than the violet sensation. If then we take the reciprocal of the extinctions of the spectrum, we shall get a curve which gives the last sensation which is extinguished, and making the maximum empirically 100, we find that it is really exactly the same sensation as the two cases of mono-chromatic vision, and corresponds to the violet sensation of the normal vision of the theory. By measuring the extinctions of the red and green-blind, we get almost identical results with those of the normal eye. Further, if the spectrum be reduced in intensity, so that the measured luminosity of the white light which forms the spectrum is 1-150th of that of an AL, 1 foot from a white screen, and measure its luminosity, we find that the same curve results. We are therefore led to the conclusion that the primitive sensation of light is the violet sensation, and that the others are "under-tones" of this one sensation. It is not therefore surprising if an "under-tone" is either totally missing or reduced in intensity, and this would correspond to complete and incomplete blindness to one colour sensation. There is a remark-

able confirmation of this in another way, viz., that those who are colour-blind from disease invariably, as far as I know, see blue at the blue end of the spectrum, the remaining part being generally described as grey, and sometimes yellowish. An examination of the various types of colour blindness with the spectrum, and with colour discs, shows that the whites which they see are, to the normal eye in the case of the red-blind, a sea-green colour, of the green-blind a red-purple, and of the violet-blind a yellow. These can well be shown by colour discs as well as by the spectrum.

From what has been said, it will be apparent that, by the spectrum, colour blindness of any type can be detected simply by diluting the different colours. Thus, a first test to be made would be to take a green of the spectrum, and dilute it with white light. Even to the normal eye, the green can be made to lose itself in the white; much more easily can it lose itself to the colour-blind, since it is to them nearly white already. An experiment will show this. Other tests of diluting red and yellow can also be made, and a good estimate made without quantitative measurement of the amount of colour deficiency present; for, it must be remembered, that it often happens that complete blindness to one sensation does not arise. The spectrum method is often impracticable and expensive, and therefore other methods to attain the same end have to be sought for.

The question of such tests for colour blindness has been carefully considered by the Committee of the Royal Society, and from all the experiments made, and from careful consideration of all cases which have come before them, they have reported that Holmgren's wool test, as originally brought out by that distinguished *savant*, is the most practicable and practical test which can be employed. This test really consists in making a person illustrate his deficiencies by the mistakes he makes in matching different colours, and answers to the spectrum test described.

The tests are wools, which I show here to-night. It will be seen that they are of almost every variety, but amongst them are shades of greys, drabs, and browns. The skeins which have to be matched are pale green of a slightly yellowish tint, a pale pink, and a bright red. The first test is to ask a candidate to pick out from a heap of wools skeins which appear to match in colour generally the green skein. Now this green skein has a hue which lies on the red side in the spectrum of the neutral points of both the red and the green-blind; and as it is very largely diluted with white, it will be seen, from what has been said before, that it may be matched with a grey, or a drab, or a yellow, or a light red, but not with any skein of wool which has a blue tint. If these colours are absolutely selected, then the examinee is colour-blind; but if he only evinces a desire to do so, he is only incompletely colour defective. This fact can be proved by testing the person by the spectrum method in the manner already indicated.

The next test is with the pink skein, as it is with this that the kind of colour defects on the Young-Helmholtz theory can be ascertained. If the candidate matches blue, green, and grey, or one of them with the pink, he is completely green-blind, but if he selects blues and violets he is completely red-blind. If he matches with the pink skein only pink he is incompletely colour-blind. The last test with the red skein is almost superfluous, but with this bright red skein a red-blind person will make a selection of dark green and brown, whilst if he be green-blind he will select a bright green and a light brown. All these tests can be proved to be correct by the spectrum method, and they, therefore, leave but little to be desired. As before said, it is these tests that the committee have recommended for adoption, and they are simple and cheap, but the whole efficiency of them lies in the selection of the colours to be matched. If the first test were a blue green or a bright green, it would be useless, as the matches made would mean very little, and the same applies to the pink skein. It is for this reason that the committee have recommended that there should be standard test skeins and no others. It has come to our knowledge that some railway companies have imagined they were using Holmgren's test, when they were doing nothing of the kind, and this simply because the test and skeins offered to the candidate to match were of the wrong hue and dilution.

The recommendations of the committee of the Royal Society are as follows:—

1. That the Board of Trade, or some other central authority, should schedule certain employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective either for colour or form, or who are ignorant of the names of colours, would involve danger to life and property.

2. That the proper testing, both for colour and

form, of all candidates for such employments should be compulsory.

3. That the testing should be entrusted to examiners certificated by the central authority.

4. That the test for colour-vision should be that of Holmgren, the sets of wools being approved by the central authority before use, especially as to the correctness of the three test colours, and also of the confusion colours. If the test be satisfactorily passed, it should be followed by the candidate being required to name without hesitation the colours which are employed as signals or lights, and also white light.

5. That the tests for form should be those of Snellen, and that they should be carried out as laid down in Appendix VI. [Form test]. It would probably in most cases, suffice if half normal vision in each eye were required.

6. That a candidate rejected for any of the specified employments should have a right of appeal to an expert approved by the central authority, whose decision should be final.

7. That a candidate who is rejected for naming colours wrongly, but who has been proved to possess normal colour-vision, should be allowed to be re examined after a proper interval of time.

8. That a certificate of the candidate's colour-vision and form-vision according to the appointed tests, and his capacity for naming the signal-colours, should be given by the examiner; and that a schedule of persons examined, showing the results, together with nature of the employments for which examinations were held, should be sent annually to the central authority.

9. That every third year, or oftener, persons filling the scheduled employments should be examined for form-vision.

10. That the test in use, and the mode of conducting examinations at the different testing stations, should be inspected periodically by a scientific expert, appointed for that purpose by the central authority.

11. That the colours used for lights on board ship, and for lamp signals on railways, should, so far as possible, be uniform, and that glasses of the same colour as the green and red sealed pattern glasses of the Royal Navy, should be generally adopted.

12. That in case of judicial inquiries as to collisions or accidents, witnesses giving evidence as to the nature or position of coloured signals or lights should be themselves tested for colour- and form-vision.

It will be seen that these recommendations are very comprehensive, and I am sure have only been recommended after careful deliberation on the subject. It remains for the Board of Trade to see them carried out intheir entirety, and if legislation be required, then there should be legislation.

DISCUSSION.

The CHAIRMAN said the report of the Royal Society's Committee was not yet published, though some stray copies had got about, and had been commented upon in certain journals, but the Council of the Royal Society at their next meeting would determine what should be done with it. It would, he believed, be presented to the Board of Trade, and by it to Parliament, and would then be accessible to the public in the ordinary way. There was a special fitness in the conclusions of the Committee being first made public in that room, because the subject of colour blindness was one of many in which the Society had taken the initiative. Eleven years ago on Monday, he delivered the first of a series of Cantor lectures on "Colour Blindness," and then endeavoured to point out that, in consequence of the complication of railway work and the crowd of vessels in many parts of the sea the question of colour-blindness had become one of grave practical importance. Although certain railways were then beginning to test their officials, and though the Board of Trade was testing candidates for the mercantile marine, neither the railways nor the Board were pursuing methods of investigation which could be relied upon, and both were rejecting candidates who ought not to be rejected, and passing those who were unfit for responsible positions in which a sense of colour was required. Some improvement took place, but not very much, and, two or three years ago, a good deal of dissatisfaction was excited amongst railway men by the methods of examination pursued by certain companies professing to use Holmgren's test; although the only point of resemblance to it was that coloured wools were used. The colours were improperly selected, and the test was practically worthless. In consequence, he was asked by the Council to read a paper on the subject, and on that occasion Dr. Edridge Green questioned some of the conclusions at which Young and Helmholtz had arrived, and subsequently, on his suggestion, communicated a paper to the Royal Society, endeavouring to substantiate the views he entertained, and to show in what respect those of Young and Helmholtz were erroneous. In consequence of the debate which ensued, the Royal Society, after communicating with the Board of Trade, appointed the committee, which had been at work for something like two years, of which Captain Abney was the Secretary, and some of its recommendations had just been read. He was pleased to find that these recommendations confirmed in every particular the suggestions made in his Cantor lectures of eleven years ago. The Committee of the Royal Society contained some of the most distinguished scientific men in England, including Sir George Stokes, and was presided over by Lord Rayleigh, those two gentlemen being the leading optical philosophers of this or any other country. It also included Captain Abney, who made a large number of most careful experiments,

and Professor Church, Professor of Chemistry to the Royal Academy, who was necessarily conversant with colour in every variety. The results of Captain Abney's work had made clear certain points which had previously been obscure, but still left the doctrines of Young and Helmholtz in possession of the field. He did not claim that they supplied a full explanation of the phenomena, but that they explained more than any other hypothesis, and he had no doubt Captain Abney would continue his researches until the deficiences were supplied. He hoped when the report came before Parliament that it would be followed by legislative action. It might seem a hardship for certain men to be excluded from following certain occupations, but it was a far greater hardship that passengers in ocean steamers should be exposed to peril by the look-out man not being able to say whether the port or the starboard side of a vessel was approaching. Moreover, if it were known that these tests would be imposed, such examinations would be made in the case of children at school, and parents would learn, at an early period, that their children could not look forward to success in certain occupations, but must betake themselves to others. The colour-blind males in this country were about 4 per cent. of the population, but the Committee, who went down to Swindon, and were allowed to test a number of the men employed there by the Great Western Railway Company, were surprised to find a much larger proportion. They did not test the signalmen or drivers, but smiths, fitters, and other men employed in the shops, and it was found afterwards that the managers had considerable doubts about the efficiency of the methods pursued by the committee, and had included as many colour-blind as possible for the purpose of being tested. They found them all out, however, and, by means of actual signals, were able to demonstrate the absolute incapacity of the men who had been discovered to be red, blue, or green colour-blind by the Holmgren test, properly applied, to distinguish with certainty the different lights under all degrees of illumination. There was still, however, another difficulty to contend with. There were many cases of incomplete red or green colour blindness, men whose vision was defective in these respects; and a question might arise whether it was sufficiently defective to require their rejection. During his work on the committee he had contrived the instrument now exhibited, in order to test these cases of defective colour sense quantitatively. It consisted of a lamp, which, for minute tests, would probably be one of Mr. Vernon Harcourt's pentane standard lamps, which cast its light into the interior of a box through an opening, which could be increased in size, by turning a screw, from 1 to 1,500 square millimetres. You could thus light up an object in the interior to any extent, and measure the amount of illumination, and express it in terms of the size of the aperture. Then, as test objects, placed where the whole light admitted, large or small, would fall upon them, be placed little discs containing dots of various colours, varying also in number and in arrangement. A person with ordinary vision could not distinguish red by a bad light, and a person with incomplete colour sense would require more light still to distinguish it from green or black; so that, with this apparatus, he could arrive at a fair expression of the degree of acuteness or defect in any particular case. Some of the discs were opaque, and some translucent; and they would be viewed accordingly. In this way, he believed, very trustworthy results would be arrived at.

Mr. J. SPILLER said he had given a great deal of time and attention to this subject, and while he had come to the conclusion, on comparing notes with others who had been professionally engaged in the same direction, that the proportion of colour-blind males was about 4 per cent., he had hitherto failed to discover a woman with this defect, although he had been assisted in his search by ladies. Of course there were cases, and it was reported that they occurred particularly amongst Quakeresses, but hitherto he had not been able to find one. The ratio was said to be one colour-blind woman to every twenty colour-blind men, but he did not know whether this statement was founded on any actual statistics.

Dr. EDRIDGE-GREEN said he had listened with great interest to the paper, and also to the Chairman's description of his apparatus for the quantitative estimation of colour blindness. When at the Chairman's suggestion he read a paper before the Royal Society, he raised objections to the Young-Helmholtz theory of colour perception. No one had as yet answered them, and they had been admitted by a large number of scientific men. Undoubtedly, normal colour vision was trichromic, but whether that trichromatism was due to three points of difference, or to three definite colour sensations remained to be proved. Everyone must acknowledge the importance of the facts Captain Abney had brought forward, but they were all perfectly consistent with the theory of three primary points of difference. It would be seen from the diagram that the chief difference between a red blind and a green blind, consisted in the neutral point of the red blind being situated more towards the violet than the neutral point of the green blind. It would also be seen that the red end of the spectrum was shortened. He held that this moving of the neutral point in the red blind was due to the shortening of the spectrum. This neutral point varied very considerably. You might find the red end shortened very little; or, in some cases it was shortened to the orange; and then the neutral point was shifted in a corresponding degree towards the violet, which would not be the case if there were certain fixed definite colour sensations. Again, if you took away one of these primary colour sensations, you would alter the

shade of the whole spectrum, and not simply cut off a certain portion at the red end; but he found that some people with a shortened red end (through a blue-green glass which cut off those rays) would make a match similar to that of the normal sighted, thus showing that it was the shortening of the spectrum which produced the defect in colour perception. He was of opinion that shortening of the spectrum and colour blindness due to psychophysical perception were two totally distinct defects. He had met with several cases in which a person saw six colours in the spectrum, and yet had a spectrum shortened either at the red or violet end. This was analogous to persons who could not perceive high notes or low notes, which was a well known phenomenon. With regard to the Holmgren test, he was sorry to differ from such an eminent committee as had given an opinion in favour of it; but he was going to bring some cases before Captain Abney, and he would probably let those interested in the matter know the result. Those who were interested in the subject would find these objections in detail in his book on "Colour Blindness," in the International Scientific Series.

Mr. LOVIBOND said he was happily not troubled with any theory. He had listened with a great deal of interest to the remarks made in reference to the lowest luminosity of white light which was perceptible by the eye; and the work he had done, although not on parallel lines with that of Captain Abney, fully bore out the great discrepancy between the visibility of different colours. He had been able to measure in units the visibility of the several rays of normal daylight, and had found that any measurement such as that given was only true for a given time, and for a given light. The power of perception of normal light increased by time—he was not prepared to say it increased regularly—and there was a difference of perception for the several colours of normal light. For instance, dealing with a half-inch area of normal daylight, one which contained six spectral colours in equal colour proportions, as tested by the spectroscope, he found that the red ray was more quickly evident on first vision, but decreased in its perceptiveness more rapidly than the violet end, or rather the violet end increased by time at a greater rate than the red. After seeing the instrument of Captain Abney's several times, and carefully reading a description of it, he fancied it was hardly as perfect as it was represented as a measure of colour, though, as a matcher of colours, it might be absolutely perfect. The incident light might be normal, but one portion of the beam was transmitted through a prism, and thrown on the screen, while the portion with which it was compared was that reflected from an angle of the same prism. His experience of prisms and lenses was not large, but he had found that beams of light got by such means were never of exactly the same composition; therefore, in comparing the colours of the two portions of the beam in this, you might have a perfect match and yet a different composition. It was difficult to arrive at a correct judgment on these lines, because the masking of a given colour by white light was an important phase of the question, and the power of masking was dependent on the quantity of white light. It was possible to get a match of different colours, provided there was but small difference in the illumination, as the masking of the one would bring it down to the level of the other. There were many other points he should like to speak to, bnt he was not prepared without further consideration.

Admiral Sir ERASMUS OMMANNEY, C.B., F.R.S., said it was very interesting to know that the lights at present used in the navy were those approved of by scientific investigators. He must confess that during thirty years' experience at sea he had never found any serious defect of vision, either in the men on the look-out, or in the officer of the watch. He had sometimes differed from them as to the exact colour of the light, but that he accounted for by the atmospheric effects at great distances. Some people did not know whether they had one eye or two, for he recently knew a case in which a young man, who had a nomination for a cadetship, only discovered on undergoing the medical examination that he had but one eye to see with.

Mr. OLIVER J. WILLIAMS suggested that, in the event of any legislation taking place, some provision ought to be made for ensuring the proper colour in the glasses used for lamps. Not unfrequently what ought to be a white light had a yellow or greenish shade, which made it very difficult to distinguish, and the copper of the lamp, to some extent, affected the colour.

The CHAIRMAN said provision was made in the report for ensuring uniformity in the coloured glasses, but the question of white glass had not come before the Committee.

General FESTING, in reply, said he did not feel disposed to argue the question of the Young-Helmholtz theory, as it would take far too long; but he simply used it as a working hypothesis, because it seemed to him that it accounted for more than any other theory did. He understood Mr. Lovibond to say that the standard comparison beam would have a different composition of light to that which went through the prism, but he did not think that could be so. The difference between them was simply that the standard comparison beam had been reflected from the surface of the prism; and he was not aware that light suffered any alteration, except polarisation, by being reflected from the surface of white glass. The only way to test that would be by analysing the light by means of a prism or diffraction grating; and if any one tried that, he thought they would find the light reflected from the surface, when split up by another prism, would give the same

result as the rest of the beam which went through the first prism.

The CHAIRMAN, in proposing a vote of thanks to Captain Abney and General Festing, said that Mr. Spiller's observations about the ladies reminded him of what was said by a friend of his, who had had great experience in colour testing, to the effect that he generally found the first impulse of a woman, when she found her son to be colour-blind, was to box his ears. The researches in girls' schools, according to American statistics, had shown that there was about the same proportion of colour-blind in a thousand women as in a hundred men.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

PLATE-GLASS MANUFACTURE IN GERMANY.

The United States Consul-General at Frankfort, in his last report, says, in reply to instructions received from his Government to supply certain information concerning the grinding and polishing of plate-glass for mirrors as practised in Germany, that there is no manufacture or export of plate-glass in southern or western Germany, except in the consular districts of Aix-la-Chapelle and Fürth. At the latter place the United States Commercial Agent succeeded, in the face of many obstacles, in obtaining information upon the subject, the substance of which is given below. Consul Mason remarks that information upon the subject of plate-glass manufacture is all but impossible to obtain in Germany. The whole plate-glass manufacture in the Frankfort division is concentrated at the two places above-mentioned, and all the manufacturers are leagued in a syndicate or pool, and access to their works is rigidly denied to everyone, especially to Americans. The reason of this is, according to Consul Mason, that most of the German manufacturers live in fear that in some way Americans will discover the secrets of their trade and transfer their industries to the United States, with the result of ultimately destroying their best foreign market. The works, where nearly all the white German looking-glass used in the United States is blown, are situated near the borders of Bavaria and Bohemia, near the city of Egar in Bohemia. There are nnmerous large and extensive works besides innumerable smaller ones, the greater number of which belong to a pool, which regulates production, prices, &c. The greater part of the glass, when blown, ultimately finds its way to the city of Fürth, in Bavaria, where it is stored in a pool warehouse, whence it is delivered to members of the pool, no one outside that organisation being able to purchase a single square foot, the capacity of each manufacturer being well known, and no increase of manufacture above a certain per-centage being permitted. After leaving the glass-blower's hands the plates are quite rough, and it becomes necessary to grind them. There does not appear for some time to have been any material improvement in the method of grinding, though perhaps there has been in the machinery. The glass is fastened to a marble or cast bed of sufficient dimensions to receive the largest plates. If necessary, smaller plates are used to fill the table. The plates are held in place by a thin bed of plaster of Paris, the moisture of which holds them securely. The upper plate is turned upside down while the glass is being placed in position, and, when ready, is turned over carefully. Both the upper and lower beds revolve in different directions. The grinding material is coarse sand at first, a finer quality being used consecutively until the plate is finished. The time required varies, from sixteen to twenty-four hours being generally necessary for this process. The next process is that of polishing the plate, to make it transparent, preparatory to the silvering. The same kinds of beds are used as in grinding, with this difference, that they are stationary; and the plates are held in position in the same manner. The polishing is done by running square discs, covered with felt, backwards and forwards across the surface. The tables usually stand in dozens, six on each side, so that, as the the rubbers move backwards and forwards, no motion or power is lost. In most of the works, the disc revolves by the motion of sliding across the surface, but in one important factory a new polisher is in use, to which a rotary motion is given by chain gearing, which performs the work in about half the usual time—fifteen minutes instead of thirty. The polish used is a native Bavarian product, and is called *potte* or *bolus*, it being an earth strongly impregnated with iron, and is kept moistened during the process, one man being required to attend six machines. As many pieces of glass may be laid upon the polishing table as it has capacity for, it being generally thirty inches by ninety. If bevelling is required—and the greater number seem by the demand to require bevelling—the plates are removed to an iron or stone cylinder twelve to fifteen inches in diameter, revolving slowly, where the edge to be bevelled is held by the operator on the face of the grinder, moistened sand being applied at the same time to the stone. A frame at the end serves to hold the glass from slipping, and steps upon this, regulate the angle of the bevel. Expertness on the part of the workman is essential in this operation. From the grinding of the bevel, the glass is taken to a round polisher, where the bevelled surface is held upon a felt cylinder supplied with *potte* until it is polished. About fifteen minutes are required for this process.

Obituary.

Dr. A. W. HOFMANN, F.R.S.—August Wilhelm Hofmann, professor of chemistry in the University of Berlin, died suddenly on Thursday, 5th inst. Hofmann was born at Giessen, April 8, 1818, and, while still a young man, devoted himself, under the direction of Liebig, at the University of his native town, to the study of the bases of coal tar and metamorphoses of indigo, but it was not until several years later that his important discovery was made regarding the composition and chemical character of aniline red. After spending three years at Bonn, Professor Hofmann, in 1848, was, on Liebig's recommendation, appointed superintendent at the Royal College of Chemistry in London. This institution, in 1853, was merged in the Royal School of Mines. In 1864 Hofmann was appointed to the Chair of Chemistry at Bonn, whence he was summoned to Berlin in the following year. He was a voluminous contributor to scientific literature, and the "Royal Society Catalogue of Scientific Papers" contains a list of 240 papers, written between 1843 and 1874 by himself alone, and 21 papers written in conjunction with others. He was elected a Fellow of the Royal Society in 1851, in 1854 he obtained a Royal medal for his "Memoirs on the Molecular Constitution of the Organic Bases," and in 1875 the still further honour of the Copley Medal. In the latter year, he received the Faraday Medal from the Chemical Society. He was awarded the Albert Medal of the Society of Arts in 1881, "for eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting chemical education and research in England."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 25.—F. E. IVES, "Researches in Photochromy."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 24.—Colonel HOWARD VINCENT, C.B., M.P., "The Extension of Colonial Trade." The Hon. JAMES MUNRO, Agent-General for Victoria, will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

Professor PERCY F. FRANKLAND, Ph.D., B.Sc., F.R.S., "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." Four Lectures.

LECTURE IV.—MAY 23.—Bacterial fermentations—New products resulting therefrom—Micro-organisms in their relation to agriculture—Nitrification—Fixation of atmospheric nitrogen by plants.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Percy F. Frankland, "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." (Lecture IV.)
Geographical, University of London, Burlington-gardens, W., 8½ p.m.

TUESDAY, MAY 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Colonel Howard Vincent, "The Extension of Colonial Trade."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. C. Jebb, "Some Aspects of Greek Poetry." (Lecture I.)
Medical and Chirurgical, 20, Hanover-sq., W., 8½ p.m.
Civil Engineers, 25, Great George street, S.W., 8 p.m. Professor W. C. Roberts-Austen, "The Measurement of High Temperatures."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.

WEDNESDAY, MAY 25... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. E. Ives, "Researches in Photochromy."
Geological, Burlington-house, W., 8 p.m.
Royal Society of Literature, 20, Hanover-square, W., 1 p.m.
Patent Agents, 55, Chancery-lane, W.C., 7½ p.m. 1. Discussion on Mr. J. Imray's paper. 2. Mr. Ernest de Pass, "Section 44 of the Patents Designs, and Trade Marks Act, 1883."

THURSDAY, MAY 26... Linnean, Burlington-house, W., 3 p.m. Anniversary Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. G. Moulton, "Faust." (Lecture I.)
Electrical Engineers, 25, Great George-street, S.W., 8 p.m.
Camera Club, Charing-cross-road, W.C., 8 p.m., Mr. W. Willis, "The New Cold Development Platinotype Paper."

FRIDAY, MAY 27...United Service Club, Whitehall-yard, S.W., 3 p.m.
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir James Crichton-Browne, "Emotional Expression."
Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, MAY 21...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Marshall Ward, "Some Modern Discoveries in Agricultural and Forest Botany." (Lecture I.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,062. Vol. XL.

FRIDAY, MAY 27, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1892.

The results are now ready, and are in course of issue to the various centres of Examination, where all inquiries should be made.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 29th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal.*

CANTOR LECTURES.

Professor Percy F. Frankland, Ph.D., B.Sc., F.R.S., delivered the fourth and last lecture of the course on "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries," on Monday evening, 23rd inst. On the motion of the Chairman a vote of thanks to the lecturer was passed unanimously.

The lectures will be published in the *Journal* during the autumn recess.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of the Committee was held on Thursday, 19th inst. Present:—Sir Frederick Leighton, Bart., P.R.A., Chairman of the Committee; Wyke Bayliss, P.R.S. Brit. Artists, Philip H. Calderon, R.A., Alexander Henderson, F. Seymour Haden, P.R.S. Painter Etchers, Sir James D. Linton, P.R.I., Edward J. Poynter, R.A., Marcus Stone, R.A., W. Hamo Thornycroft, R.A., the Earl of Wharncliffe, Sir Henry Trueman Wood, M.A., Secretary of the Royal Commission, and J. W. Beck, Secretary to the Committee.

COLONIAL COMMISSIONER.

Mr. B. Howell Jones has been appointed Commissioner for British Guiana at the Chicago Exhibition, by Lord Viscount Gormanston, Governor of British Guiana.

HORTICULTURAL DEPARTMENT.

The following letter from Mr. Samuels, Chief of the Department of Horticulture, to Mr. McCormick, has been received for publication:—

World's Columbian Commission,
Office of the Director-General of the Exposition,
Chicago, Ill., U.S.A.,
14th April, 1892.

Hon. Robert S. McCormick, Official Representative, World's Columbian Exposition, London, England.

Dear Sir,—In reply to your request, made to the Chief of the Department of Foreign Affairs, for information concerning the growth and development of horticulture in the United States, I have the honour to make the following report:—

The census reports show that there were engaged in 1890, in the nursery business in the United States, 4,510 firms, with an invested capital of $52,425,669·51, and giving employment to 47,936 men and women; of this number only 42 were in existence prior to 1860; while even as late as 1870 only 436 firms were in business. In 1880, the number of nurseries had increased to 1,212, and thus the marvellous growth of the nursery interest can be illustrated in no better way than by stating that, in the space of one decade, the number of firms in the business has more than doubled, and the invested capital has been increased 75 per cent. $18,325,935·86 is shown to be invested in 596 seed farms, which, including the seed merchants, represents a small per cent. of the money invested in the seed trade.

Floriculture, as a commercial business, was almost unknown at the beginning of the present century. There was a total of 4,659 establishments in 1890; of these 2,795 have been started since 1870, and

1,797 since 1880. These establishments, including fixtures and heating apparatus, were valued at \$38,355,722·43, while the tools and implements used were valued at \$2,747,846·59; the wages paid in one year amounted to \$8,483,657. The sales for a single year in plants and cut flowers reach the grand total of \$26,211,805·77.

Even the great number of firms who have commenced business during the last decade have not been able to keep pace with the demand for horticultural products, and custom house receipts each year indicate larger orders from European firms. More than twenty houses in Great Britain have travelling agents who visit every State in our country, and sell annually 500,000 roses, 250,000 deciduous shrubs, 2,000,000 apple, pear, plum, and cherry seedlings, hundreds of thousands of gooseberries, currants, &c., 100,000 rhododendrons and azaleas, large quantities of palms and ferns, \$200,000 worth of orchids, and many tons of flower and vegetable seeds. It is safe to state that the United States is the best field, present and prospective, for Great Britain's horticultural productions.

The most enterprising firms of the United Kingdom appreciate the advantages to be derived from a creditable display at the Columbian Exposition, as they will there reach not only their patrons in this country, but from all parts of the world. Applications have been made for liberal amounts of space. Other firms, desiring to more widely cultivate a taste for horticulture, and let the world receive the benefit of their experiments in producing novel and choice varieties of trees and plants, have made large donations to the Exposition, and the department of horticulture is in almost daily receipt of fine collections.

There are some large and rare specimens of plants, which can only be procured at the world-famous Kew Gardens, and I am very anxious to secure the donation or loan of some of them. Any exhibits from Kew will be a great source of pride to Englishmen from all parts of the world. The following list of plants will be very desirable, and will attract universal attention:—*Aristolochia hians*, *A. longifolia*, *A. goldieana*, *A. ringens*; *Amorphophallus campanulatus*, *A. grandis*, *A. lacourii*, *A. nivesus*; *Dracontium albostipes*, *D. annulatum*, *D. aspersum*, *D. carderi*, *D. gigas*, *D. fecundum*; *Amorphophallus titanum*, *A. leopoldianus*, *A. teuszii*, *A. virosus*; *Dracontium polyphyllum*; *Pancratium guianense*.

There may be other curious specimens which could be supplied, and the Curator of the gardens will know the many unique and curious species and varieties that will be of interest to the millions of visitors.

The handling and care of exhibits will be under the control of the most skilled help obtainable, which fact will insure against loss; and, when desired, the safe return of all loans will be guaranteed.

Yours respectfully,

J. M. SAMUELS,
Chief, Department of Horticulture.

Proceedings of the Society.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 25, 1892; J. W. SWAN, F.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Benson, George Henry, Holly Lodge, St. Saviour's, Jersey.
Ketchley, Rev. H. E., B.A , Devon Lodge, Malvern.
Shaw, William Thomas, 110, Bunhill-row, E.C.
Skinner, Arthur B., B.A., 2, The Residences, South Kensington Museum, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Castle, Sydney Charles Courtenay, 40, Chancery-lane, W.C.
Gubbins, John Harington, British Legation, Tokio, Japan, and Oriental Club, Hanover-square, W.
Smith, Sir Donald A., K.C.M.G., LL.D., Montreal, Canada.
Woolf, Mortimor, 16, Greville-place, N.W.
Wyatt-Davies, Ernest, B.A., Trinity College, Cambridge.
Young, Herbert Edward, White Hart-street, High Wycombe.

The CHAIRMAN, in introducing Mr Ives, said Mr. Ives needs no introduction to an English audience; his work in connection with the translation of the continuous gradation of an ordinary photograph into discontinuous gradation is known throughout the world. The excellent quality of the half-tone photographic engravings—so profusely employed in the illustrated literature of America—is largely due to Mr. Ives' initiative. But to-night we are to hear and see the results of his labours in a different direction, that of photography in natural colours, an object of desire that arose in the minds of almost the earliest workers in photography. No sooner had that miracle of science—the production of a photograph in light and shade—been wrought, than the insatiable striving after something higher and better — the best attribute of the human mind — asserted itself in the desire for colour in addition to light and shade; and very soon this desire received the stimulus of what appeared to be, if not a complete, at any rate, an approximate solution of this problem. In the Exhibition of 1851, I remember seeing a photograph on a Daguerreotype plate, which showed some quite vivid colours in the dress of a doll. It was a photograph by Becquerel, and it seemed as though very little more had to be done to realise a perfect result; but that seeming has proved to be illusive; the colours were, to a large extent, accidental, and they were not permanent, and as a matter of fact very little more has been accomplished since that time in that particular line of work-

ing. The colours were due, not to any selective action of the light corresponding to them, but to quantitive effect. The principle was false. The only substantial advance that has been made since that time has been made on the different principle of working, followed by Dr. Vogel and Mr. Ives; unless the recent announcement in connexion with the achievements of Mons. Lippmann should prove to be true. For 14 years past Mr. Ives has laboured to produce colour photographs by the composite method, believing that this was the only road by which success was to be reached.

The paper read was—

COMPOSITE HELIOCHROMY.

By F. E. Ives.

Most people look to original discovery for the solution of photographic problems, and most photographical problems are solved by original discovery. There have been a few important exceptions to the rule. The production of the so-called half-tone photographic block—the latest substitute for wood engraving—now grown to a very important industry, is one example. The first practical solution of this problem—a process which I patented in America, in 1881—was a purely mechanical invention, utilising photographic processes already known. The so-called Woodbury-type process is another purely mechanical invention, based upon well-known photographic processes. The method of colour photography, which I have named composite heliochromy, and which the French prefer to call photochromy or composite photochromy, is also an invention, utilising comparatively old and well-known photographic processes. It is not a simple invention, but comprises several inventions by different men. The original suggestion was made 27 years ago by her Majesty the Queen's painting master, Henry Collen.* Briefly stated, Collen's idea was to make three negatives of an object, one by red light, one by yellow, one by blue—the so-called primary colours of Brewster—to print from each pair of these negatives (superposed as one) a transparent positive having the colour (in the shadows) of the light that produced the third negative, and to superpose these coloured positives on a white surface. A Baron Ransonnet, of Austria, is credited with the same suggestion in the same year, but I have not the reference.

It was not possible to carry out Collen's suggestion at that time, because there was no known process by which photographic plates could be made sensitive to the separate single colours only; and no photographic plates were sensitive enough to red and yellow to admit of the production of such negatives by exposure through selective colour screens. Had it been possible to carry it out, the results must have been very imperfect, not only because the entire procedure is based upon a false and misleading theory of colour, but also because superposing two negatives to act as one, would double the intensity of such parts as represented white, grey, or pale coloured objects, with the result that if the colour prints were made to show all the details of the negatives, the finished heliochromes would show all bright colours as if mixed with equal parts of black pigment.

On November 23, 1868, Ducos Duhauron, of Paris, applied for a patent* for a process which differed from Collen's only in the manner of carrying out the same idea. Like Collen, he assumed that the spectrum is made up of three primary colour rays and mixtures thereof. He said, "My procedure rests on the principle that the simple colours are limited to three—the red, the yellow, and the blue—the combination of which, in divers proportions, produces the infinite variety of shades in nature." Like Collen, he expected to solve the problem by superposing red, yellow, and blue prints from negatives made by yellow and blue, red and blue, and yellow and red light. But instead of using plates sensitive to simple colours only, he proposed to use plates sensitive to all colours, and to prevent the action of colour rays not wanted by filtering them out with coloured glasses placed in front of the sensitive plates; and, instead of superposing two negatives to act as one to make a colour print from, he proposed to make two colours (that is, two-thirds of the spectrum) act to produce each negative, which amounts to the same thing. He proposed to make one negative through an "orange" screen, calculated to absorb the blue light and transmit the red and yellow; one through a "violet" screen, calculated to absorb the yellow light and transmit the red and blue; one through a "green" screen, calculated to absorb the red light and transmit the yellow and blue.

It was no more possible to carry out this idea in Duhauron's way in 1868 than to carry it out in Collen's way in 1865, although Duhauron, having succeeded in making

* *British Journal of Photography*, October 27, 1865, p. 547.

* Class xviii., sec. 3, serial No. 83,061

photographs by exposing ordinary photographic sensitive plates through glasses that were orange, green, and violet to the eye, imagined that he had succeeded in carrying it out. In reality, the photograph made through an "orange" screen must have been made chiefly by either the green, the yellow-green, or the ultra-violet spectrum rays, as can readily be proved by photographing the spectrum itself through a bright orange screen (not an orange-red one), on such a plate as he used. The photograph made through a "green" screen, that transmitted freely both the yellow and the blue rays, must have been made chiefly by the blue rays, and the photograph made through a "violet" screen must have been made without any action by the red rays, and with a great deal by the invisible ultra-violet rays.

Soon after Duhauron published the details of his process, Charles Cros, of Paris, published another modification of Collen's idea.* Like Collen, Cros proposed to make one negative by the action of red light, one by yellow, and one by blue; but by exposing the sensitive plates through red, yellow, and blue glasses, instead of employing plates sensitive to the single colours only. Instead of superposing the respective pairs of these negatives to make each colour print, he proposed to make a green print from the negative made by red light, a violet print from the negative made by yellow light, and an orange print from the negative made by blue light. Cros's plan was free from the defect of doubling intensity on those parts of the negatives representing pale or uncoloured objects; but the advantage gained in this way would be lost again in the production of green, violet, and orange-coloured prints.

The principle of colour selection advocated by Duhauron is identical with that distinctly proposed by Collen, to whom alone the credit of the original invention appears to belong; but Duhauron and Cros, besides proposing a more reasonable plan for obtaining the negatives, further suggested that optical superposition of positive images from the three negatives might be substituted for the superposition of transparent coloured prints.

On December 3rd, 1869, M. Poirée, of Paris, in a communication to the Photographic Society of France,† suggested that better results might be had by making a greater number of negatives—a separate negative for each spectrum region.

* Described in *Photographic News*, October 8, 1869, p. 483.

† *British Journal of Photography*, 1870, p. 26.

In 1873, Dr. H. W. Vogel, of Berlin, discovered that bromide of silver can be made sensitive to the less refrangible spectrum rays by treatment with certain dyes; and this, with the subsequent discovery of other and better colour sensitisers, supplied the means for carrying out either Collen's or Poirée's idea. Duhauron, one of the first to avail himself of these discoveries, made some practical progress, and, in 1876, abandoned Brewster's colour theory and patented a modified process,* based upon the observation that, while there appeared to be "seven" principal spectrum colours, three colouring substances would "serve to express them." The colouring substances he named for this purpose are blue, carmine, and yellow; and he decided that, in order to make such a process reproduce the colours of nature, the negatives should still be made through orange, green, and violet glasses.

At this period, Duhauron's orange-screen negatives were made on chlorophyl plates, and must have been made chiefly by the red spectrum rays. In 1878,† he announced that he had substituted eosine for chlorophyl, so that he must finally have made them chiefly by the greenish-yellow spectrum rays. The significance of this fact has not been generally recognised. The production of three negatives, one through an "orange" screen, one through a "green" screen, and one through a "violet" screen, is a very indefinite procedure. A negative may be made through an "orange" screen chiefly by the action of red rays, or orange rays, or yellow rays, or yellow-green rays, or green rays, or ultra violet rays, according to the character and intensity of the "orange" colour of the screen and the method of sensitising the photographic plate for colour. Duhauron, who never recognised the necessity of testing his process by photographing the spectrum itself, not only did not find out what it is necessary to do in order accurately to reproduce the natural colours, but at different times he did very different and inconsistent things without himself knowing that he did so. The facts can very readily be demonstrated by first showing the spectrum absorption of various "orange," "green," and "violet" screens, and then photographs of the spectrum which

* British patent, July 22, 1876, No. 2,973.

† "Traité Pratique de Photographie des Couleurs," Paris, 1878; *Photographic News*, 1878, p. 115.

have been made on plates differently sensitised for colour. I shall now proceed to demonstrate this point.

In 1879, Cros* also abandoned the idea that red, yellow, and blue are primary spectrum colours, but held that there are three primary spectrum colours and mixtures thereof, and that these primary colours are orange, green, and violet. Like Duhauron, he decided to make negatives through orange, green, and violet screens, and prints in blue, carmine, and yellow. Cros, like Duhauron, was apparently ignorant of the fact that very different negatives can be produced through one and the same screen, and he also allowed all of the invisible ultra-violet rays to act in producing the negative of the "violet" screen.

In 1885, Dr. H. W. Vogel† proposed to make the colour-prints with dyes identical in spectrum absorption with the colour-sensitisers employed in making the negatives. This does not amount to a principle of colour selection, because the entire spectrum can be photographed on plates sensitised with dyes that cannot be combined to reproduce some colours, and even without any dye at all, by the use of suitable colour-screens.

Some time previous to 1889, I do not know the exact date, the Young-Helmholz theory of colour vision was first recognised in connection with this subject, by Dr. F. Stolze, of Berlin.‡ He said, "Although the colours correspond with certain external processes in nature, there is also no doubt that colour as such is nothing objective, but a subjective sensation, based upon the peculiar irritation of the visual nerves by those external proceedings. We can, therefore, only hope to produce a picture in natural colours, when we are enabled to reproduce upon the same the proceedings which furnish to us the colour impression." "Thomas Young . . . assumes that there are three kinds of nerve fibres, sensible to red, green, and violet. Objective homogeneous light excites all three; but with red the first is excited strongly, the second and third weakly; with blue, the second and third moderately strong, the first weakly; with violet finally, the third strongly, and the first and second weakly. If all three kinds of nerves are equally strongly excited, the impression of white light will take place." Dr. Stolze suggested, but rather indefinitely, a procedure which, although not really representing the application of this theory, was more nearly consistent with it than were any of the older ones. The theory itself was defective as a basis of procedure, Clerk Maxwell having shown that the fundamental red sensation is not at all excited by the blue-green, blue and violet rays, the fundamental green sensation not at all by the red or violet rays, and the violet sensation not at all by the red, orange, or yellow rays.

* Bulletin of the French Photographic Society, 1879, p. 23.

† *Annalen der Physik* (N.S.), xxvii., p. 130; *Photo. News*, 1887, p. 568.

‡ *Anthony's Photographic Bulletin* (N.S.), 1888, pp. 516, 555, 588, 647, 678.

It was at this stage that, after ten years of experiment along the same lines as Duhauron, Cros, and Stolze, I myself made certain improvements, and claimed the credit of bringing order out of chaos, by devising a procedure which not only recognises the facts which support the modern colour theory, but which definitely represents the application of that theory.

This process, although in a general way somewhat similar to those which preceded it, really represents a distinctly new principle, which is that of making three photographs by the action of light rays as they excite the three fundamental colour sensations, and superposing these photographs by means of lights or in transparent pigments which suitably represent the corresponding fundamental colour sensations.

In February, 1888, I demonstrated, at the Franklin Institute, Philadelphia,* a process in which the colour selection was according to a definite plan, and proved by photographing the spectrum itself, adjusting the colour screens to obtain definite density curves in the spectrum negative. This was the first publication in which a really definite mode of procedure was indicated; but it was not until November of the same year† that I demonstrated the method so modified as to definitely represent the application of the Young-Helmholtz colour theory, in accordance with Maxwell's measurements of the relative power of different spectrum rays to excite the respective fundamental colour sensations.

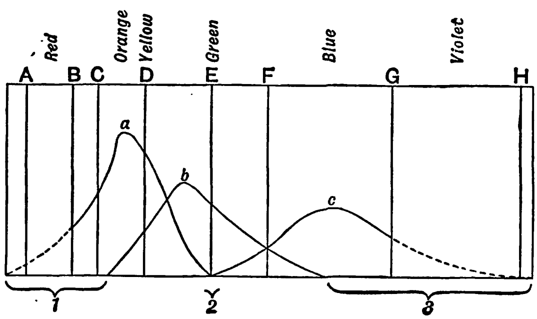
A little study of Maxwell's diagram, showing the result of his measurements, will show that the application of this new principle involves very important departures from the older methods of procedure. In this diagram, which I reproduce, 1, 2, 3 are spectrum colours which represent fundamental colour sensations, because each excites one sensation only, and

* *Journal of the Franklin Institute*, cxxv., 345.

† *Journal of the Franklin Institute*, Jan., 1889.

a, *b*, *c* are curves showing the relative power of different spectrum rays to excite the respective fundamental colour sensations.

The first remarkable fact to be gathered from the study of this diagram is, that the rays which represent a fundamental colour sensation are in no case the ones that most powerfully excite that sensation. The red sensation is excited by all the spectrum rays from red to green, but most powerfully by the orange; and the negative to represent the effect upon the fundamental red sensation must therefore be made, not through a red glass, or by the red rays, but by the joint action (in definite proportions) of the red, orange, yellow, and yellow-green spectrum rays. The negative to represent the effect upon the green sensation must be made by the joint action of the orange, yellow, yellow-green, green, and green-blue spectrum rays, in proportion to their power to excite that sensation. The



MAXWELL'S DIAGRAM.

negative to represent the effect upon the blue-violet sensation must be made by the joint action of the blue-green, blue, and violet spectrum rays, in proportion to their power to excite that sensation.

By photometric measurement of the density curve of a spectrum negative, the relative amount of action by the different spectrum rays may be found. It is, therefore, only necessary, in order to secure action by different rays in any definite proportions, to use such a combination of sensitive plate and colour screen as will yield a spectrum negative having a density curve corresponding to the graphic curve representing such proportionate action.

Sensitive plates and colour screens that will yield three negatives of the spectrum, having intensity curves like the three graphic curves in Maxwell's diagram, will produce a permanent photographic record of the effect of light from any object upon the three fundamental colour sensations. This can most readily be accomplished (with separate plates) by exposing a cyanine-stained rapid gelatine-bromide plate through a double screen of aniline yellow and chrysoidine orange, of suitable intensity, for the red sensation; a commercial "orthochromatic" plate through a screen of "brilliant" (aniline) yellow, of suitable intensity, for the green sensation; and an ordinary gelatine bromide plate through a very thin piece of plane polished green glass for the blue-violet sensation. The screens that will secure the same results all on one kind of plate are far more complicated and difficult of adjustment; but anyone who possesses a photospectrograph and a good assortment of coal-tar dyes can, by the exercise of some skill and ingenuity, make the adjustments for himself.

The set of three photographs of any object, made as I have indicated, of course show no colour whatever; but they contain, in a permanent form, such a graphic record of the natural colours that, in order to reproduce them to the eye, it is only necessary to superpose the three positive images, either upon a screen, or upon the retina of the eye—the one representing the red sensation with pure red light, the one representing the green sensation with pure green light, and the one representing the blue-violet sensation with blue-violet light. The blending of the three images will excite exactly the same sensations as the light coming directly to the eye from the object itself. The synthesis can also be made with superposed transparent colour-prints, and this is the plan which has received the most attention, although the simplicity of *optical* superposition commends it to scientists, and is really more convincing to everybody.

Both Duhauron and Cros had the idea of synthesis by optical superposition as well as by colour-prints, but neither of them succeeded in carrying out the idea practically. Superposition by triple optical lantern projection was first carried out successfully by me, in my demonstration at the Franklin Institute, Philadelphia, in February, 1888, showing a landscape photographed from nature. I employed a single lantern-box, having three optical systems close together, with a triple lime-light jet, and the three positives mounted side by side in a single wooden frame, behind red, green, and blue glasses. A considerable variety of subjects were shown with the same lantern in November

of the same year, when I first clearly stated and demonstrated the principle which represents the application of the Young-Helmholtz-Maxwell colour theory.

The first workable plan of optical superposition other than by lantern projection was devised by Antoine Hippolyte Cros, brother of Charles Cros, and patented in 1887. In this device, the three pictures are arranged relatively to each other like the steps of a staircase, aud by means of a peculiar system of mirrors, some of which are attached to the face of a rapidly revolving wheel, with open spaces between them, the different pictures are seen by the eye in one optical plane, in such rapid succession, that they appear like a single picture, with colours blended. The same device, which is a very ingenious one, was to be used also for making the negatives; but it is so clumsy. so troublesome, by reason of the necessity for providing means to keep the mirrors in motion, and includes such an extremely narrow angle of view, that I believe it has no practical value.

Both Duhauron and Cros taught that synthesis by optical superposition should be accomplished with the same mixtures of l ght rays that acted to produce the different negatives. The picture made through an orange screen was to be seen by the light transmitted by the same, or an exactly similar screen, and so on.

I hope I have made it clear that such a procedure is quite irrational, in view of the facts which support the Young-Helmholtz-Maxwell colour theory. The photograph made by the joint action of various different colours of spectrum rays must be seen by rays of one colour only. Spectrum rays of various colours excite one fundamental sensation, but only spectrum rays of one single colour will serve to represent that fundamental sensation.

I have taken particular pains to emphasise this fact in every paper I have published upon this subject, but have not yet succeeded in impressing it upon the minds of the French writers, who continue to assert that my procedure does not differ in any essential particular from that indicated by Duhauron and Cros. I think that this one difference alone is of vital importance.

The application of the Young-Helmholtz-Maxwell theory involves important changes from the older methods, not only in the negative process, and in the synthesis by optical superposition, but also in the production of permanent colour-prints. Theoretical considerations alone led me to conclude that a transparent colour-print from either negative could be made to perform exactly the same function that the positive transparency from the same negative performs in the synthesis of triple-lantern projection, and a simple experiment with the triple lantern confirms my conclusions.

The white disk that we obtain in screen projection by mixing the red, green, and blue-violet lights, corresponds to the white paper which may form the basis of a permanent colour-print heliochrome. When we insert the positive of the red sensation in its place in the lantern, its shadows cut off the red light, leaving the disk still white except in the shadows, where there remains only a mixture of the other two lights, green and blue-violet; a transparent print from the same negative performs the same function when laid upon the white paper, provided that its shadows also cut off the rays that excite the fundamental red sensation, but freely transmit the green and blue-violet. I have found that a coal-tar dye, sold as "thio blue A," absorbs those rays which excite the fundamental red sensation, but freely transmits the green and blue-violet; a Woodburytype process print in this colour fulfils the requirement for a permanent print to represent (by transparency) the effect upon the fundamental red sensation. By a similar process, I have found that fuchsine fulfils the requirement for making a print to represent the green sensation, and aniline-yellow the print for the blue-violet sensation. It is true, as I have already pointed out, that these permanent colour-print heliochromes will show a slight degradation of colour in ordinary white light, but they should exactly reproduce the natural colours when viewed in a white light produced by mixing the red, green, and blue-violet spectrum rays.

The theoretical conditions of success have, therefore, been realised for the negative process, and for all three methods of synthesis.

But there is another aspect of this subject which, from a practical and commercial point of view, is quite as important as that of realising the theoretical conditions of success. I am of the opinion that, however perfect results this process could be made to give, it would not be reasonable to expect it to be commercially successful, so long as complicated by the necessity for making three separate photographic negatives and three separate photographic colour-prints, in order to obtain a single reproduction in colours. Such a complicated procedure might be

carried out successfully by experts, dealing with such subjects as paintings or similar art objects, but would not be available for landscape photography, or in the hands of amateurs.

The only way to make the process simple and reliable enough to be available generally, is to reduce the number of negatives to one, and dispense with the colour print process altogether. This I have accomplished by the invention of a camera that makes the three pictures on a single plate, by one exposure from one point of view, and a device, which I have named the heliochromoscope, that optically recombines the triple black and white photograph into a single photograph reproducing the natural colours. With this camera (about the size of a kodak) and the heliochromoscope (the size of a hand stereoscope), the reproduction of the natural colour by photography is not only made practically available, but reduced to the simplicity of stereoscopic photography.

I wonder if people are prepared to realise the full significance of this fact. The hope of producing colour *prints* by a direct process, is calculated to discredit the value of an equally simple method that accomplishes substantially the same result in a different way. I said, "substantially the same result," but, in a way, it is a better result, because it is quite impossible than any coloured picture, with its distracting surroundings and surface reflections, should ever produce such a perfect illusion of nature itself as we may obtain with this little instrument, consisting of several small mirrors, two of them transparent, placed at certain angles with reference to the photograph, and inclosed in a box. If the heliochromoscope was merely a box for seeing photographs in colours, it might be regarded with indifference; but I hold that it is as far from being merely that as the phonograph is from being merely a device for making a noise by turning a handle. It is capable of accomplishing for us, in the reproduction of colours, more than the phonograph accomplishes for us in the reproduction of sounds, because the illusion is more perfect. I quite believe that the writer who, in a recent article in *The Speaker*, described the heliochromoscope as a toy, comparable to the kaleidoscope, would have been capable, under similar circumstances, of comparing the phonograph to a baby's tin rattle.

I have also tried to simplify and perfect the colour-print process. The employment of the new triple camera, making one operation take the place of three, is one step in that direction. The use of the dyes I have mentioned, corresponding to the colours produced in screen demonstration, is another. The production of a single print instead of three, cutting the images apart only when ready to be dyed, is another. Experiment with the Woodburytype process is another. The Woodburytype process offers the vitally important advantage for reproduction in large numbers that, having found experimentally the right amount of dye required in each of the three colour-prints, an indefinite number can be made without any variation; it will be available for the commercial production of lantern slides. These appear to be real advances; but, after all, the further complication and mechanical difficulties of carrying out the print making process, render it comparatively unsatisfactory up to the present time—and the value of composite heliochromy must be estimated, for the present, on the basis of its application to the photographic reproduction of the natural colours by optical superposition.

If the heliochromoscope is the only solution of the problem that is sufficiently simple to be practicable for general introduction, there is, nevertheless, a field for the application of the method of colour projection for lecture illustration. Here, also, we escape the complication and mechanical difficulties of colour printing, and obtain results which are permanent as far as the colour record goes, and which can be shown to many people at one time. It will be necessary, however, to employ the arc electric light in order to project landscape views at night as perfectly as they have already been projected by sunlight. The value of the method cannot be fully demonstrated with the lime light.

In conclusion, I would like to say another word to emphasize the fact, which I think is quite sufficiently demonstrated in the heliochromoscope, that although we are not able to make photographs in natural colours of exactly the kind that people have been looking for, we have, nevertheless, found a true solution of the problem of reproducing the natural colours by photography, as remarkable in its results as the telephone or phonograph, more perfect in the illusion of nature than would be possible in coloured pictures, and almost as easy to realize as stereoscopic photography. It seems to me that this is an advance so great that it should finally break down the prejudice against the idea of composite heliochromy which has

grown out of the long series of failures of unscientific, complicated, and impractical methods. With no more operations than are required to make an ordinary photograph, we now make a photograph that, as we are able to see it, reproduces nature itself, light, shade, and colour.

DISCUSSION.

The CHAIRMAN said photography in natural colours, as generally understood, was something different from what Mr. Ives had now shown. What had been wished, but hardly hoped for, was a photograph in which all the colours of nature would be reproduced on one plane surface, in one picture, directly in the camera, and by one print. Mr. Ives had not given them the whole loaf, but he had produced something which might perhaps be esteemed a good half of it. He had shown some very beautiful results, and had explained the means and the principle on which they have been produced with singular clearness and precision. He had shown that in the production of the photographs to form the basis of colour photograph combination, not only had the character of the sensitive surface to be considered in photographing the radiations from particular colours, but also the screen to be combined with a particular quality of colour-sensitivness in the plate, and that the separate consideration of either screen or sensitive plate was useless. Mr. Ives's teaching and procedure in relation to the production of negatives for the production of colour photographs were applicable not only to the kind of pictures he had shown that evening, but also threw a strong light on the principles to be followed in copying paintings and coloured objects generally, with a view to rendering in correct monochrome all the different values of the colour in the oil painting. He conceived that to be a very useful application of the principles now explained.

Professor ROBERTS-AUSTEN, F.R.S., wished to express his appreciation of the extreme ingenuity displayed in the construction of the camera, and in arranging these marvellous optical effects which had been shown. He had had the privilege of visiting Yellowstone-park, and could bear testimony to the extraordinary fidelity with which the marvellous colour effects there seen had been reproduced.

Mr. B. FRANCIS COBB said there was very little room for discussion; they had simply to listen and learn, and admire the extraordinary results Mr. Ives had obtained. It had frequently been said that if ever colour photography was to be achieved, it would be by some means at present little suspected, or by some totally new appliance. Mr. Ives was certainly opening the way to what in future might lead to very great results, and he (Mr. Cobb) could only hope that Mr. Ives would continue the researches which all were watching with the greatest interest, and that later on he would come before them again with still further advances.

Mr. VAN DER WEYDE asked if anything had been done in the way of portraiture by this method. He apprehended the exposure would have to be prolonged, and the light very strong, so that perhaps the sitter would have to close his eyes during the operation.

Mr. WILLIAM H. WARD said he had had the opportunity, last winter, of seeing, in Mr. Ives's own house in Philadelphia, several of the pictures now shown, and he could say that when displayed by sunlight they were quite fifty per cent. better. That would give some idea of the improved effect which would be obtained with a lantern fitted with an arc light.

Sir HENRY TRUEMAN WOOD said it would be interesting if Mr. Ives could give some further information as to the way in which he regulated the exposure for each of the three pictures produced on the same film. As he understood, they were all produced simultaneously on one film and developed at the same time, and consequently the amount of exposure for each must be carefully regulated. It was obvious that the picture produced by the red rays must require a very much longer exposure than the one produced by rays of higher refrangibility; it would be interesting to know how it was done. One could understand that it might be regulated by varying the size of the aperture, or by other means. A great deal of credit was due to Mr. Ives for the extreme ingenuity with which he had rendered practically useful a method which had been in the minds of a great many people for a long time, and which had been accomplished, with a varying amount of success, by previous experimenters. But Mr. Ives had certainly achieved in this particular direction a very distinct success. The practical application of it had yet to be seen, though it was not difficult to see that it had many possibilities of usefulness.

The CHAIRMAN said he should like to know what kind of plate was most suitable for taking these negatives, and whether Mr. Ives had a preference for one particular kind of plate rather than another.

Mr. IVES in reply, said he thought a special plate should be manufactured for this work, slightly modified from anything now on the market, but in order to make the operation sufficiently easy and convenient he had adopted commercial orthochromatic plates; the results shown were all obtained with commercial plates manufactured by Messrs. Carbutt of Philadelphia. The one picture which would be seen in the heliochromoscope, a bouquet of English flowers, was taken on an Edwards' isochromatic plate, which was very similar, There were two methods of securing simultaneous equal exposure for three pictures,

the plates not being anything so sensitive to red as to the other colours. If the three pictures were taken at one exposure through a single lens, the ray being divided after it passed through the lens, he had a number of ground and smoked glasses of different degrees of density, and having adjusted the colour screen to give the density grades he wanted in the spectrum negative, he inserted one or more smoked glasses until he found three pictures developed together after the same exposure. He had another camera in which the pictures were taken on one film by three separate lenses, and in that case the diaphragms were varied; that for the red being much larger than that for the other two. It would be possible to take a portrait by this process now, but it would require an exposure of three or four minutes in a strong light. Plates could be specially prepared which would reduce the exposure in a strong light to possibly 15 or 20 seconds, but inasmuch as the process was not practically available for portrait-work at present, he had not troubled himself with experiments in that direction.

The CHAIRMAN then proposed a vote of thanks to Mr. Ives, which was carried unanimously.

INDIAN SECTION.

Thursday, May 19, 1892; Sir CHARLES BERNARD, K.C.S.I., in chair. The paper read was "The Administration of the Imperial Census of 1891 in India," by JERVOISE ATHELSTANE BAINES, I.C.S., Chief Census Commissioner for India.

The paper and report of the discussion will be printed shortly in the *Journal.*

FOREIGN & COLONIAL SECTION.

Tuesday, May 24, 1892; the Hon. JAMES MONRO in the chair. The paper read was "The Extension of Colonial Trade," by Colonel HOWARD VINCENT, C.B., M.P.

The paper and report of the discussion will be printed shortly in the *Journal.*

Miscellaneous.

IRRIGATION IN SYRIA.

The United States Consul at Beirout says that, generally speaking, the character of the irrigation works in Syria is of the most primitive kind. From rivers the conveyance of water is usually by means of canals or rough ditches, badly levelled and aligned, often without masonry, except at the intake, the weirs being re-made every season of boulder, stone, and brushwood, rarely over three feet high. Irrigation from springs is generally much the same as from the rivers, though necessarily on a smaller scale. From wells the system universally adopted is that of the "Na'hura." The "Na'hura" is of the simplest construction, cheap, quickly made and repaired, and easily worked, while it raises a comparatively large quantity of water. Its construction consists of a clumsy cog-wheel fitted to an upright post, and made to revolve horizontally by a donkey, mule, or horse attached to the sweep; this turns a similar one perpendicularly placed at the end of a heavy beam, which has a large wide drum built into it directly over the mouth of the well. Over this drum revolve two rough hawsers or thick ropes, often made of myrtle twigs and branches twisted together, and upon them are fastened small earthen jars or wooden buckets. One side descends while the other rises, carrying the small buckets with them; those descending are empty, while the ascending ones are full, and, as they pass over the top, they discharge into a trough which conveys the water to the cistern. The length of the hawsers and number of buckets depend upon the depth of the well; for the buckets are fastened to the hawsers about two feet apart. The wells are of different depths, but generally average from 10 to 12 feet. It is claimed that, with good animal power, two gallons of water can be raised every second. The "Shaduf," so conspicuous on the Nile, is not used in Syria, but on the shores of Lake Tiberias an apparatus much like it has been seen at work, and the well sweep and bucket is also met with in many places. Another method may be observed on the plains of central Syria. It consists of a large buffalo skin, so attached to cords that, when let down into the well, it opens, and is instantly filled, and, being drawn up, closes up, so as to retain the water. The rope by which it is hoisted to the top works over a wheel, and is drawn by donkeys, mules, oxen, or camels, which walk directly from the well to the length of the rope, and then return, only to repeat the process, until a sufficient quantity of water is raised. The wheel and bucket, of different sorts and sizes, are much used, where the water is near the surface, and also along rapid rivers. For shallow wells, merely a wheel is used, whose diameter equals the desired elevation of the water. The rim of this wheel is large, hollow, and divided into compartments, filling the place of buckets. A hole near the top of each bucket allows it to fill, as that part of the rim in revolving dips under the water. This, of course, will be discharged into the trough, when the bucket begins to descend, and thus a constant succession of streams falls into the cistern. The wheel itself may be turned by donkeys, mules, oxen, or camels. Small water-wheels are sometimes turned by feet, but the process is tedious, toilsome, and not productive of much result. At Homs, in the Tripoli district, there is a lake or artificial basin of about four

thousand acres in extent, formed by draining the Orontes river. It is very shallow in summer, probably not over ten or fifteen feet at the deepest part, but will reach a depth estimated at from thirty to forty feet in the winter. The lake was made for the double purpose of regulating the summer flow of the Orontes and for obtaining sufficient water to irrigate the extensive gardens of Homs. This lake is the only artificial system of irrigation on a large scale in the country, but it is not kept in very good repair. The Pools of Solomon, at Tyre, may also be mentioned. They are natural artesian wells of great volume, irrigating some fifteen hundred acres of garden land by artificially raised conduits.

THE MANUFACTURE OF PAPER IN COREA.

The United States Consul-General at Seoul, in his last report, says that paper manufacture is one of the leading industries of Corea. This paper is highly esteemed, and always forms part of royal presents, and of the tribute paid to China. Besides its use for writing and for books, it is employed in a great diversity of ways. It serves as string, and in the manufacture of lanterns, fans, umbrellas, shoe soles, hats, boxes, and coats. It is also used for covering floors, walls, and ceilings, and, stretched on frames, supplies windows and doors. It is highly prized in China and Japan, and is especially sought after for the manufacture of umbrellas. It is made from the bush of the mulberry order (*Broussonetia papyrifera*), which is indigenous, growing in many parts of the kingdom, but thriving best in the moist, warm climate of the south. It is chiefly grown from cuttings for this especial purpose, and the wild and cultivated plants are said to be of equal value. The bark, which alone is used, is generally gathered in the spring, and it is boiled for a long time in water, in which a quantity of wood ashes has been mixed, until it becomes a pulp, the mass having been beaten during the whole time of the boiling. Fine bamboo screens are then placed in shallow wooden vats, and a ladle full of the pulp is evenly spread over the screen by a dexterous circular motion of the hand. This operation is repeated once or twice, or as often as may be necessary—the more frequent the operation, the finer the paper—and the screen allowed to drain into the vats, until a proper consistency is reached, the drippings being thus saved. They are placed on a hot *kang* floor to dry. After the drying has proceeded far enough, the paper is laid on a hot floor, and ironed by hand. The long lines in the paper show strands of the bamboo screens, and their nearness, distinctness, or absence indicate the fineness or otherwise of the paper. They are almost imperceptible in some grades of paper, while in others they are distinct and far apart. Paper is made by the Paper Guild, a numerous and prosperous association. The province of Chulla is the chief seat of manufacture.

VITICULTURE IN BOSNIA AND THE HERZEGOVINA.

Her Majesty's Consul-General at Serajevo says that the Austrian Government is paying great attention at the present time to the cultivation of the vine in Bosnia and Herzegovina, and to the making of wine in these provinces. More than a year ago the tithe on wine, which, as well as the tithe on grapes, had till then been levied, was finally abolished, and even vineyards planted on hitherto unproductive ground were exempted from the grape tithe for the first ten years. Two horticultural stations have been established—one at Dervent, in the north of Bosnia, and the other at Mostar, in the Herzegovina; at the former of which about 37 acres, and at the latter 24 acres, have been laid out in vineyards. Not only can the inhabitants receive at these stations practical instruction in the culture of the vine, but, as far as possible, they are furnished from them with cuttings to plant new vineyards. At Mostar there is also a wine press, and the peasants can, therefore, learn the most improved methods of making and storing wine. The climate and soil of a great part of the Herzegovina, and more especially the districts of Mostar, Konjica, Ljubuski, Ljubinje, Stolac, and Trebinje, are eminently suited to the growth of the vine, whereas the climate of Bosnia appears to be too cold and the summer too short, except in the valley of the Save, for the grapes to reach full maturity. In Bosnia there are not more than about 620 acres laid out in vineyards, while in the Herzegovina at least 12,000 acres are devoted to the cultivation of the vine. The descriptions chiefly cultivated are of native origin. The red grapes are known by the name of *Blatinica*, and the white by that of *Zelenka*, and both are considered very good for the table. Some vines have also been brought as an experiment from Burgundy, and others from Kecskemeter in Hungary. The total annual yield of grapes in the two provinces is estimated at from 8,000 to 9,000 tons. A very large proportion of these grapes are eaten in the country, a certain quantity are exported to Austria Hungary for the table or for manufacture of wine, and the remainder are made into wine on the spot and consumed in the province. This native wine is prepared in a very primitive way and with little care, the white and red grapes being generally mixed together. It is, therefore, not of very good quality and does not keep well. In colour and flavour it much resembles the wines of Dalmatia, but contains less alcohol. The wholesale price of wine in the Herzegovina after last year's vintage, which was an abundant one and the grapes of excellent quality, was from 30 to 35 florins per hectolitre (from £2 10s. to £2 18s. per 22 gallons). The phylloxera has not yet made its appearonce in Bosnia or the Herzegovina, and the peronospera, which has been very prevalent of late years, appears, owing to the dryness of the season and the measures taken by the Government to combat it, to have done but little injury in 1891.

Notes on Books.

THE OPTICS OF PHOTOGRAPHY. By J. Traill Taylor. London: Whittaker. 1892.

Since the publication of "Monckhoven's Photographic Optics"—a work of practical value, though in places inaccurate, and now to a large extent obsolete—no writer seems to have dealt specially with the important subject of photographic lenses. Descriptions of many of the special arrangements of lenses used for photographic purposes are given in photographic text-books, and of course all treaties on optics deal, at least theoretically, with the subject of lenses generally. There does not, however, appear to be any book which will give the now numerous students of photography at once that elementary knowledge of scientific optics they ought to possess, and that practical information about the instruments they are using which is essential to their proper use. This want Mr. Taylor has undertaken to supply, and his long familiarity with the subject renders him admirably well qualified for the work. The photographer will find here to his hand a general description of the principles on which his lenses work, the method of their construction, their defects and the means for remedying or diminishing them, directions for testing of lenses, and descriptions of the various classes of lenses old and new, together with much other information all of a thoroughly practical nature.

"BLACK AND WHITE" HANDBOOK TO THE ROYAL ACADEMY AND NEW GALLERY PICTURES, 1892: with Biographies and a Brief History of the Royal Academy, by C. Lewis Hind. London: "Black and White."

This volume contains nearly one hundred and fifty pages of engravings of the principal pictures in this year's Exhibition of the Royal Academy, and prefixed is an account of the Academy, and portraits and short notices of all the Royal Academicians and Associates.

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 31.—WILLIAM DE MORGAN, "Lustre Ware." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 30 ... Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. A. Nettleton, "Manufacture of Vinegar." 2. Dr. S. Rideal, "The Petroleum Jellies of Commerce." 3. Dr. C. R. A. Wright, "Certain Aluminium Alloys."
Surveyors, 12, Great George-street, S.W., 3 p.m. Annual General Meeting.
British Architects, 9 Conduit-street, W., 8 p.m.

TUESDAY, MAY 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. W. De Morgan, "Lustre Ware."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. C. Jebb, "Some Aspects of Greek Poetry." (Lecture II.)
Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS). 11 a.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual Meeting.
Royal Scottish Geographical Society, 20, Hanover-square, W. 8½ p.m. (London Branch.) Mrs. Bishop (Isabella L. Bird), "A Journey through Lesser Tibet."

WEDNESDAY, JUNE 1 ... East India Association, Westminster Town Hall, S.W. 2½ p.m. Surgeon-General Sir William Moore, "The Opium Question."
Entomological, 11, Chandos-street, W., 7 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 20, Hanover-square, W. 8 p.m.

THURSDAY, JUNE 2...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. E. A. Floyer, "The Disappearance of Desert Plants in Egypt." 2. Mr. F. H. Perry Coste, "Insect Colours." 3. Lantern Demonstration.
Chemical, Burlington-house, W., 8 p.m. Prof. R. Meldola and Mr. F. W. Streatfield, "Ethylene Derivatives of Diazo-amido Compounds."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. R. A. Sterndale, "Cyclopean Architecture in Polynesia."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. G. Moulton, "Faust." (Lecture II.)
Manchester Geographical Society, 44, Brown-street, Manchester, 8 p.m. Rev. L. C. Casartelli, "Commerce in Relation to Geography."
Camera Club, Charing-cross-road, W.C., 8 p.m., Mr. A. F. Stanley-Kent, "Practical Photo-Micrography."
Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

FRIDAY, JUNE 3 ... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Ludwig Mond, "Metallic Carbonyls."
Geologists' Association, University College, W.C., 8 p.m. Mr. F. W. Rudler, "The Fathers of British Geology."
Philological, University College, W.C., 8 p.m.
Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m. Prof. O. J. Lodge, "On the Present State of our Knowledge of the connection between Matter and Ether. An Historical Summary."

SATURDAY, JUNE 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. Marshall Ward, "Some Modern Discoveries in Agricultural and Forest Botany." (Lecture II.)

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, JUNE 3, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ALBERT MEDAL.

The Council of the Society of Arts have, with the approval and sanction of the President, H.R.H. the Prince of Wales, awarded the Albert Medal to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 29th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

Further particulars as to arrangements will be announced in future numbers of the *Journal.*

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 1st inst. Present: The Attorney-General, M.P., Q.C., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., M.P., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Major-General J. F. D. Donnelly, C.B., James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., George Matthey, F.R.S., Sir Saul Samuel, K.C.M.G, C.B., with Sir Henry Trueman Wood, M.A., as Secretary.

COLLECTION OF GUIDE BOOKS, &c.

The Royal Commission are forming a collection of Maps, Guide Books, Photographs, Railway and Steamship Guides, Programmes, &c., and other printed matter likely to supply useful information to exhibitors at, and visitors to, the Chicago Exhibition.

The collection is placed in the library of the Society of Arts for consultation by persons interested. It will be open to members of the Society, exhibitors, or their agents, and persons introduced by either of the above.

A considerable number of books, &c., have been collected, but the Royal Commission will be glad to receive any works suitable for the above purpose for addition to the Collection.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 17, 1892; General Robert Maclagan, R.E., in the chair:—

The paper read was—

MUD, A MATERIAL IN PERSIAN AND EASTERN ARCHITECTURE.

By William Simpson,

R.I., M.R.A.S., Hon.Assoc.R.I.B.A.

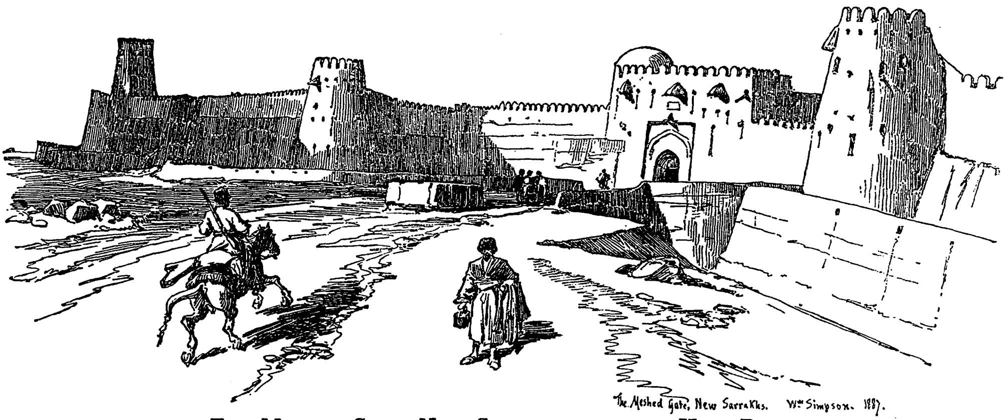
It is necessary to premise that under the term "Mud" I include sun-dried bricks. When bricks have been burnt in the fire, the material becomes entirely changed, and ceases to be mud, so I exclude them from consideration in the present paper as a building material. Wet earth made into blocks and dried in the sun differs in no way from a layer of the same laid on a wall.* Both

* Bricks of this kind, "when placed one upon another after being imperfectly dried, combined, under the influence of the weather and their own weight, into one homogeneous mass so that the separate courses became undistinguishable. This latter fact has been frequently noticed in Assyria, by those who had to cut through the thickness of walls in the process of excavation." Perrot and Chipiez, "A History of Art in Ancient Egypt." vol. i. p. 113.

methods were used in the East, and often combined in the same building. The reason for this is soon found out if you attempt to raise a mud wall. A layer of two or three feet thick must be allowed to dry and consolidate before another is placed on it, because the weight above would press out the soft material below, and the whole would tumble down. In some localities a layer of mud is put down at the commencement, and while that is drying bricks are made to be placed above.

It was during the cold season of 1884-85, in travelling through Persia at the time of the Afghan Boundary Commission, that the importance of mud in connection with building and architecture first attracted my attention. I had to pass from Tehran eastward, through Khorassan, and into Afghan Turkestan.* Along the whole of this route mud is the building material. Some of the serais—that is, caravan serais for the accommodation of travellers, are of burnt brick, but these are about the only exceptions. Not only villages, but large towns are built of mud or sun-dried brick. The defensive walls are of the same material; even such large towns as Sabzawar, Nishapur, Meshed*, and new Sarrakhs, are fortified with walls of this kind. Fire-burnt bricks may have been more frequently used in former times, that was when the country had been more prosperous, and before Turkoman raids began. On the remains of former towns a few fire-burnt bricks† might be seen scattered about, but the great mounds seemed to be composed of nothing but earth, suggesting that these fragments were the exception. On realising this almost exclusive use of one building material, in one region, my mind naturally recalled what I had seen in India; where, although stone and fire-burnt brick

FIG. 1.



THE MESHED GATE, NEW SARRAKHS, ON THE HERI RUD.

are largely used, yet the villages are over very large districts wholly constructed of mud. In Afghanistan it is the same. The Fort at Peshawer, which was Afghan territory up to Runjit Singh's time, is a mud one. Jellalahad is surrounded by a mud wall. From the Khyber Pass to Tehran the towns and their defences, as well as the villages, are almost identical in their material as well as in their general appearance.

These statements show that over a large geographical space in the Eastern world the building material, at the present day, is almost exclusively mud. I have been thus far speaking of what I have seen with my own eyes. To this may be added the practice of other countries. I believe that it is the same over most of Central Asia. It is now accepted that in Mesopotamia it was largely employed; and we know that in Egypt, from the earliest times to the present day, it has been the principal means employed in structural erections. It was largely used in Greece in ancient times, and also in Spain. It was known in South America and all along the Pacific Coast, from

* See paper on "Experiences on the Afghan Frontier," by William Simpson, *Journal of the Society of Arts*, March 26, 1886, where details of the journey will be found.

* The blocks of Figures 1 to 5 and 7 have been kindly lent by the Council of the Royal Institute of British Architects, for use in the illustration of this paper.

† At Kala-i-Maur, on the Khushk, I measured some fire-burnt bricks, which were 11¾ inches square, and the thickest were 2¼ inches thick. Another was 10¾ inches square. There was an oblong brick, 7½ inches long. It looked much like our own bricks, but it was only 1½ inches thick. Perrot and Chipiez state that the ancient bricks in the Euphrates Valley were from 15½ to 15¼ inches square, and from 2 to 4 inches thick. Persian sun-dried bricks are about 8 inches square, and 2 inches thick.

Peru to San Francisco. The word "dobies," for sun-dried bricks, is a familiar term—this is derived from the Spanish word *adobes*.* In 1873, I visited the original church dedicated to St. Francis, and which gave its name to the now well-known town in California—this church was constructed with "dobies." Mud houses were not uncommon in England in the past; and they are yet known in Devonshire, where the stuff they are constructed with is called "cob." I might largely increase this list of localities, but enough has been given to show how extensively mud has been used in the past as well as in the present for building purposes. I am under the impression that its importance in connection with building has hitherto been overlooked. The lithic architecture of Greece having been traced back to wooden forms has led to the study of wood as an early structural material; and up to the present little or nothing has been done with mud.

Owing to this it has been generally assumed that wood supplied the first means by which the primitive man had formed a shelter to himself as a protection from the weather. The Australian native, as he was represented some years ago at the Colonial Exhibition, was a good example of the simple beginnings of wooden architecture; but a very slight consideration will bring to the mind the possibility that the use of mud might, at least, be equally primitive. It would all depend upon where the primitive man found himself; if trees were scarce, or none whatever were to be found, the wetting of earth and raising a wall with it must have been very soon discovered. The children making "mud pies" might have given the first hint. Once begun, the progress of mud architecture would be considerable. Those who began their architectural style with branches of trees could not have made any advance until some kind of implement was invented, by means of which the wood could be cut and fashioned; and the "stone age," when stone tools came into use, is a comparatively late one in man's history. The mud builder, on the contrary, required no tools; his hands were sufficient for every purpose. He may have been content at first with an enclosure formed by four walls. A covering of grass or reeds would soon suggest itself; this, although rude and primitive, would be the first complete human habitation. But more than that, it would be the beginning of the "house"—the "home," which, from the relations and associations it produced, must have been one of the most important steps in the history of early civilisation. This, of course, is only a speculative suggestion as to what took place, but in the nature of the conditions it is a probable one. We find a confirmation of this when we remember that the Nile Valley and Mesopotamia, two preeminently mud building regions, are now noted for their very early civilisation.

The great antiquity of the use of mud as a building material can be established from a number of references to history. Like most things that were important to man in his early condition, this can be traced back even to the mythical period. In Persia, at least, we have traces of it. Firdusi, in the *Shah Namah*, relates how Jemshid, now known as a mythical personage, introduced a better civilisation among the people; among the improvements it is told how, "He taught the unholy Demon train to mingle water and clay, with which, formed into bricks, the walls were built, and then high turrets, towers, and balconies, and roofs, to keep out rain, and cold, and sunshine." It is naturally inferred that the bricks made by the children of Israel in Egypt were sun-dried from the use of the straw in them. The making of bricks is often represented in the sculptures of Egypt. M. Maspero thus describes the process: "The ordinary Egyptian brick is a mere oblong block of mud mixed with chopped straw and a little sand, and dried in the sun. At a spot where they are about to build, one man is told off to break up the ground; others carry the clods and pile them in a heap, while others again mix them with water, knead the clay with their feet, and reduce it to a homogeneous paste. This paste, when sufficiently worked, is pressed by the head workman in moulds made of hard wood, while an assistant carries away the bricks as fast as they are shaped, and lays them out in rows at a little distance apart to dry in the sun."* As to the speed with which these bricks could be made, M. Maspero has to judge from the workmen of the present time, and he says that a modern good workmen can easily mould 1,000 in a day, and that after a week's practice he may be able to produce 1,200 or 1,500, and some can turn out as many as 1,800. As the modern appliances are the same as were used in former times, he assumes that the results would be similar. The dimensions generally

* *Adobes*, or *dobies*, is probably a variant of the Arabic *tob* or *toob*, allied again to the Coptic *tobi*, which was also the Egyptian word for brick.

* "Egyptian Archæology," p. 3.

adopted for ordinary bricks were 8·7 by 4·3 by 5·5—I presume these numbers represent inches —a larger size were 15·0 by 7·1 by 5·5.* He says, " Burnt bricks were not often used before the Roman period." In a note he adds that such bricks, " are found of Ramesside age at Nebesheh and Defenneh; even there they are rare, and these are the only cases I have yet seen in Egypt earlier than about the third century A.D." This note is valuable from its showing how exclusively sun-dried bricks must have been the rule in ancient Egypt.

Mr. Flinders Petrie has, in his explorations, come upon, in more than one instance, what might be called the "foundation stone" of Egyptian buildings, but as there was no stone, but a number of articles, such as gold, silver, lapislazuli, &c., a more exact term to give it would perhaps be that of "foundation deposit." Among the articles, and generally in a very central position, he always finds a small model of a mud brick.† This will show that along with the other objects it had most probably acquired some symbolic signification.

Maimonides gives a description of building mud walls; he says, " The builders take two boards, about six cubits long and two cubits high, and place them parallel to each other on their edges, as far apart as the thickness of the wall they wish to build; then they steady these boards with pieces of wood fastened with cords. The space between the boards is then filled up with earth, which is beaten down firmly with hammers or stampers; this is continued until the wall reaches the requisite height, and the boards are then withdrawn."‡ I understand that this is taken from the Talmudical authorities, but the great Rabbi does not explain in what part of the world it was practised.§

* In a note at the end of the volume the author says that, "in the Delta, at least, the sizes of bricks, from the Twenty-First Dynasty down to Arabic times, decrease regularly. Under the Twenty-First Dynasty, they are about 18 by 9 by 5 inches; early in the Twenty-Sixth, 16½ by 8¼ by 5; later, 15 by 7½; in early Ptolemaic times, 14 by 7; in Roman times, 12 by 6; in Byzantime times, 10 by 5; and Arab bricks are 8 by 4, and continue so to our times." Persian sun-dried bricks, at the present day, are generally about 8 by 2.

† See the *Illustrated London News* for Sep. 11, 1886, where drawings of these objects, with their relative sizes and position, are given.

‡ *Transactions* of the Soc. of Biblical Archæology, vol. viii. p. 409.

§ The Hebrew word for brick is *Lebanah.* This also means "white." The term is also applied to the moon, owing to its whiteness. Rawlinson, in his "Herodotus," suggests that there was some connection between the word "brick" and *Sin,* the Babylonian deification of the moon, who was the God of Architecture. This would be a very interesting point, if it could be established; but I understand that it is as yet doubtful.

Sanchoniathon, or whoever it may have been that wrote under that name, mentions Chrysor, and identifies him with Vulcan, as having invented many useful things; and it is quoted that,—" Men worshipped him after his death as a God, and they called him Diamichius —*i.e.*, the Great Inventor, and some say his brothers invented the making of walls and bricks. After these things, of his race were born two young men, one of whom was called Technites—*i.e.*, the Artist; the other, Autochthon—*i.e.*, Earth-born, or generated from the earth itself. These men found out how to mix stubble with clay, and to dry the bricks so made in the sun."

According to Professor Sayce the Assyrians had a month called Sivanu, which he translates the "month of making bricks." The Accadian name had the same signification; and it corresponded to the month of May. This would be the season after the rain, when the sun had begun to be hot, and the drying of the bricks would be easily accomplished.

These references will show, at least, how important this building material must have been looked upon in very early times. Its first use, or invention, was ascribed to mythical personages, thus attributing to it a kind of divine origin. In our own age it is difficult to realise how such ideas could have existed in the past, but from the authorities quoted there can scarcely, I think, be much doubt on the subject.

I shall now give a few details of the manner of building in mud, most of which are derived from what I saw in Persia. Many of the methods I saw there I have since found are also practised in other parts of the world.

It was pointed out to me that, in the larger towns, on entering a house, you have often to descend from the level of the street to the ground floor. It was explained that this results from utilising the earth on which the house stands, and thus saving the expense of transporting the building material from outside the town.

In good houses a foundation is laid, varying from two to four feet in depth, formed of rough stones or broken fire-burnt bricks, and piled up with mud and lime. This is carried up a foot or so above the ground, before the mud wall is commenced. In villages, where everything is rude, this foundation is made of any kind of rubbish that is found handy. This is a very interesting feature of mud architecture, to which I shall have something to say farther on. Its object is no doubt to give strength

where the wall would be liable to friction from the street traffic; and probably to prevent to a certain extent damp from rising. It would also be a safeguard against another serious danger —that is, if water were to accumulate by any chance round the base of the mud walls, and remain long enough to soak through, a very serious catastrophe might take place from the house tumbling down. I cannot recall to my memory any foundation of this kind in the mud houses of India. Village houses in the north-west of that country are usually built on a *chabootra*, which is a raised platform of mud, about a couple of feet in height, and this forms the floor of the house. This platform, by raising the foundation of the walls above the ground, may, perhaps, serve some of the purposes of the layer of stones in the Persian foundations.

The walls of Persian houses vary from two to four feet in thickness. This depends entirely on the quality of the house and the means of the builder. Thick walls make a cool house, and that is a desirable thing in the climate of Persia. If upper rooms are required, a greater strength of wall will be necessary. The mud is either laid on in layers or in the form of bricks.* As already explained, a layer of two or three feet of mud must be allowed to dry to a certain extent before another is laid on it, else the soft mud below will give way from the weight above. On this account both methods are generally practised. I remember an officer, who tried to make a mud hut for himself, when General Sir Samuel Browne's force was in Jellalabad. In this case, the walls were run up at once the full height required; this was not very high, for it was a small place, and he had dug a foot or two down below the surface for his floor, but his walls tumbled in. When he adopted the system of layers—letting each dry before the other was laid on—he succeeded, and made a very comfortable place for himself. In garden walls hollow bricks are used for the top, to give lightness. These bricks are called *sanduk*, a word meaning "box," which is descriptive of their character.† The tendency in mud building to produce thickness below in the walls, and lightness above, is most marked in the walls of villages and towns. These are all built with a visible batter. The earth taken out to form the ditch gives an abundant supply of material for a town wall, and a thick, solid mass at the base is necessary to give strength to the defence.

Where wood is plentiful, as in the province of Mazenderan, flat roofs are the rule. In large districts of Persia wood is scarce. I understand that south of Tehran there is very little timber, and there is also great danger from the white ants, so the vault- or barrel-roof is the usual means employed. According to Strabo, it was the same in Mesopotamia; he says, "All the houses are vaulted on account of the want of timber."* These vaulted roofs were frequent enough along the route I travelled. I have seen whole villages with them. Square buildings would have a dome; and a semi-dome at one end of a barrel-roof seemed to be a favourite method in that part of Persia. What struck me with surprise was the facility with which these villagers could construct such roofs. If there was any irregularity in the plan of the house, the barrel-roof was extended or drawn in, as the case might be, to cover the space. Of course in the villages it was all a very rough and ready kind of work, evidently done by no better principle than that of rule of thumb.

I was still more surprised when I learned that these vaulted roofs were constructed without centres. I can suggest so far how this is accomplished. Their bricks are said to be about eight inches square and only two inches thick; this gives a large flat surface and not a very heavy brick for its size. They place these bricks, not perpendicularly, but at an angle, so that the one rests partly on the other, and by the use of a little *gatch*, or gypsum, which is plentiful in Persia, they can be made to adhere till the key-brick is put in. Perrot and Chipiez give a drawing of an arched conduit at Khorsabad,† where the bricks are shown in the construction almost similar to what I have just described, and I feel sure that these conduits were also made without centres. In describing the construction of these conduits, the writer says: "We may believe the notion of building in this way would never have occurred to the Assyrian architects but for their habit of dispensing with timber centres."

* Sun-dried bricks are called *khest* in Persian; the fire-baked bricks are *ajur* or *aujur*. In Afghanistan, *khist* is used for both burnt and unburnt bricks. *Gill*, with a hard *g*, is Persian for mud.

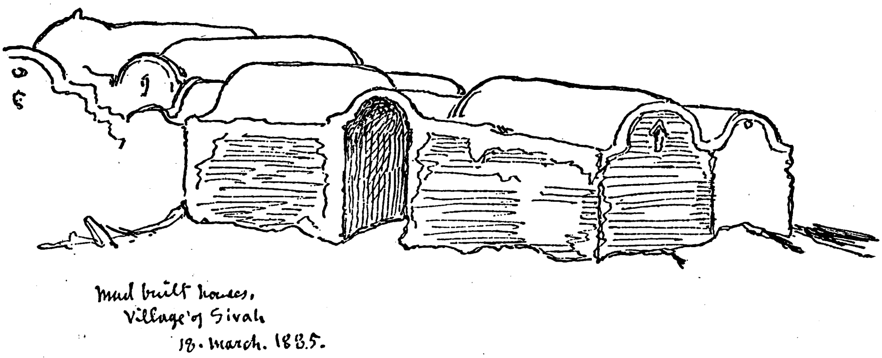
† This recalls an old practice of Eastern architects, in constructing domes with pots, thus producing a considerable reduction of weight, and consequent diminution of thrust. A well-known example of this is the dome of St. Vitale, at Ravenna.

* *Strabo*, B. xvi. ci. 5. See also B. xvi. ciii. 10.

† See a *Hist. of Art in Chaldea and Assyria*, vol. I. p. 232, Fig. 93. See also Fig. 92, p. 229.

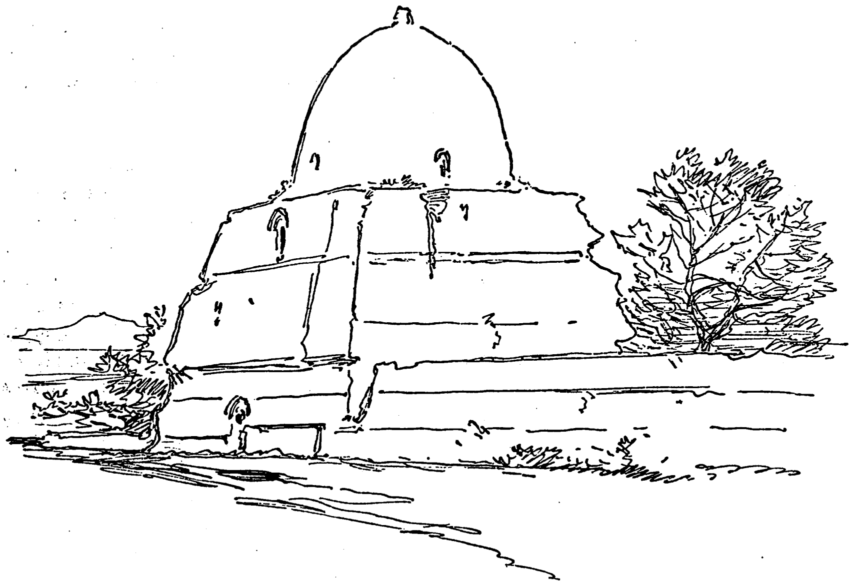
As the possibility of forming a vaulted roof without centering may be new to many in this western part of the world, I shall add further evidence, which is supplied by Perrot and Chipiez. They say: "We may refer those who are especially interested in constructive methods to M. Place's account of the curious fashion in which the workmen of Mossoul will build a pointed vault without the help of any of those wooden centerings in use in Europe. In our day, certainly, the masons of Mossoul use stone and mortar, but their example none the less proves that similar results may once have been obtained in different materials. A vault launched into mid-air without centering, and bearing the workmen who were building it on its unfinished flanks, was a phenomenon calculated to astonish an architect."* Rich gives details of a similar method, which is practised in Bagdad. It is also affirmed that the Byzantine architects produced arches, if not domes, without the aid of centres. M. Place* describes one method of making vaults without centres, which he saw in Kurdistan, and in this case they were women who performed the operation. They placed rings

FIG. 2.



MUD BUILT HOUSES, VILLAGE OF SIVAH, KHORASSAN.

FIG 3.



TOMB, CONSTRUCTED OF MUD, WITH DOME.

* *Hist. of Art in Chaldea and Assyria*, by Perrot and Chipiez, vol. i p. 167.

* *Ninive et l'Assyrie*, vol. i. pp. 266-7. The church of Mousta, a town in the centre of the island of Malta, was built in the present century by the local masons; and they constructed the dome—said to be the third largest in Europe—without centres.

of dried clay, each smaller than the other, till the dome was completed. The evidence of these authorities, added to what I learned in Persia, would seem to establish that this was the practice over all the wide space from the Mediterranean to Central Asia.

In Persia the mud walls are covered over with a mixture called *kahgill*,* which is composed of mud and chopped straw; this serves to prevent the rains from washing away the walls, as it hardens the surface. The application of this mixture is generally repeated every two years.

Thus far, I have been dealing mainly with details of construction, and with ordinary dwellings. The general impression in most minds will no doubt be that mud building only belonged to a rude condition of civilisation, and produced houses that were little better than hovels. I have now to point out that this manner of building was developed into a highly decorative style which, in itself, would entitle it to a place in the history of architecture. This position, it appears to me, has been almost entirely overlooked by those who have written histories of architecture. Architectural writers always treat upon primitive wood constructions, because forms can be traced from it up to the highly developed styles of Greece, Egypt, and India. The same process can now be gone through with the primitive mud as a building material. Before I have done, I shall point out architectural forms which owe their origin to this source. At present my purpose is to show that it was carried to a pitch of finish and refinement that rendered it worthy for the palace or the temple. The following letter sent to me by General Sir Charles Wilson would, in itself, he a sufficient evidence. Sir Charles is well acquainted with western Asia, and being an engineer officer, he may be trusted as an authority. He says, "It may interest you to know that in Anatolia there is much mud building; and that most of the great buildings of the Seljuks, more especially their great palace at Konieh, were of mud faced with glazed tiles. Some of the minarets of their mosques, built with sun-dried bricks, arranged in patterns and faced with glazed tiles, or with the ends of the bricks glazed, are extremely beautiful in their decay. The Seljuk architecture is Persian with a development of its own." Here are mosques, or temples, and a palace constructed with sun-dried brick, which are declared by this high authority to be beautiful even in their decayed condition.

A somewhat similar development was reached in Peru, but with different materials. Squier, in his "Land of the Incas," describes the palace of Chimu, where the *adobes*, or sun-dried bricks were covered with stucco, on which beautiful arabesques were produced in relief.* From these ornaments he calls one of the great apartments the "Hall of Arabesques;"* of which he speaks in warm admiration, and adds—"no description can give an idea of the character of these *relievos*." In describing other ornamentation of the same kind, he says, "here, as elsewhere, there are traces of colour."†

I understand that the higher developed condition of this style of architecture in Persia was attained by covering the mud walls with glazed tiles. The tiles, it must be understood, were covered with ornament. Those who are familiar with the artistic qualities of Persian tiles may be able to form some idea of what could be thus produced. I regret to say that I saw very little of it. The part of Persia through which I passed had been so utterly devastated by the Turcoman raids, scarce a vestige of anything ancient remained. At Meshed, only, I saw a gateway, built with sun-dried bricks and covered with ornamental glazed tiles, but it was a very poor specimen of art; yet, it told me what might be done in this style if the work could be put into the hands of real artists. Meshed is celebrated, and is a well-known place of pilgrimage, from its having the tomb of the Imam Reza in it. The shrine is said to be decorated with some very fine tiles; but the whole enclosure, which is in the centre of the city, can only be entered by the faithful.

The interior of a mud building may also be decorated with glazed tiles; but in Persia *gatch*, or gypsum, is plentiful, and where ornament is required it is much used. In an old tomb, at Sarrakhs, I saw some particularly good ornament in this material; and it appeared to me to be all hand work. I chanced to come upon one room that impressed me with the capabilities of this manner of decoration. It was at a place called Mazinan, on the first march eastward within the Khorassan frontier. There appeared to be the remains of more than one town here; I strolled over to that which was nearest, and found that it was

* The word is *Kah* = straw, and *gill* = mud. In Indian villages the mud floors are washed over with a thin mixture of mud and cow dung.

* *Peru, or the Land of the Incas*, p. 135.

† *Ibid*, p. 154.; also at p. 411.

all formed of mud. It was rough work scrambling over the heaps, but at last I reached a mass that had probably been the *arg*, or citadel, and here is the description I jotted down at the time, immediately after the visit:—"It was with some difficulty that I was able to climb to the top, as the mound had been used as a quarry—a mud quarry—of the building material of the region. The mass forming the mound was artificial, for I found bits of red burnt bricks or vessels embedded in it. The top was a curious maze of rooms, courts, stairs, and roofs, much of it in a tumble-down condition, and it was rather difficult to find a way in places. From the superior finish of some of the rooms, I concluded that a governor, or some important man had lived in this place of security, but there were ruder additions, which showed that servants, or perhaps a more simple kind of people, had in all probability used some part of the place at a later time. The solid mass of mud or earth was about twenty feet high, and the houses were above that; still they were not all on the same level, for I went up and down short flights of steps. The whole was of mud or sun-dried bricks. Here I found at least one illustration of what can be done with such material which, from the high finish it presented, was rather a surprise to me. It was the best room in the place; the dimensions were small, somewhere about fifteen by ten feet. The lines of the interior were all perfectly straight, and at right angles to each other. The best houses in London are not more exact or more finished in their details than what I found here. The mud must have been carefully put on at first, but the high finish was produced by *gatch*, or gypsum. There were very handsome niches all round the walls, and the fireplace had been elaborate, but some act of destruction had taken place, and the fragments lay on the floor where they had fallen. The ornament was simple; there were some slight mouldings on the space between the niches. Lines had been drawn into the gypsum, and an ornament had been repeated by means of a stamp which had been pressed or imprinted when wet, producing a raised pattern; the impression left was so clean and perfect, it might have been gilt, and it would have been quite equal to the work we have at home on picture-frames. The contrast between this highly-finished interior with what was outside was very striking."

It was from what I thus chanced to see, even in this desolated region of Persia, that it began to dawn upon me what this peculiar manner of construction really had been. It was the exclusive building material of that part of the world. The simple houses of the villages are formed of it; the defensive walls of the towns, and which, owing to the Turkomans, were an absolute necessity to every village, were constructed of the same. The houses of the rich were also formed with it, and it had been developed into a highly decorative style of architecture; all this grew upon me, and I felt that this peculiar manner of building had not received the attention of writers its merits have entitled it to.*

One would not expect much durability from such walls, yet I was informed that there are walls of sun-dried brick in Ispahan which are over 300 or 400 years old. This quality of durability will no doubt depend upon the character of the soil. About Tehran the earth is sandy, while at Ispahan it is said to be more adhesive. In the northern part of Persia, according to Mr. A. Finn, of the Consular Service, the walls of the old city of Erig are still standing, and they are said to have existed for 1,200 years. There still remains at Cacha, in Peru, a wall of *adobes*, or sun-dried bricks—part of the temple of Viracocha, which was in a ruined condition about three centuries ago, when Garcilasco described it, and this wall is still standing to a height of 40 feet.† There are the remains of very old walls in Egypt. Maspero describes one at Abydos, called "Kom-es-Sultan," or "the Mound of the King," an old fortification, where part of the crude brick wall still stands, "from 24 to 36 feet high."‡ Maspero does not give a precise date, but from what he says, I understand that he places the origin of

* It has not been altogether overlooked. I learn that it has been dealt with in more than one work. M. J. F. Blondel's *Cours d'Architecture Civil*, Paris, 1777, his editor, Patte, gives a description of the mode of constructing buildings "toute on terre dite pisé." It is treated upon in a work, published in Berlin, written by H. F. Rödlich, entitled *Praktische und historische Darstellung Erdbankunst*. There is an article on "Pisé" in the *Dictionary of Architecture*, Arch. Publication Soc. Miss Yule, in Murray's *Handbook for Greece*, gives some very valuable references to it; and I would refer all who are interested in the subject to look up the *Quarterly Review*, vol. lviii. 1837, for an article "On Cob Walls," by Mr. Richard Ford, the father of Sir Francis Clare Ford, our Ambassador at Constantinople. It is a very learned article, and, at the same time, very amusing. I may also refer to a paper, read by myself to the Royal Institute of British Architects in 1887, on "Mud Architecture," and published in the *Transactions* of the Institute for that year.

† Squier's *Peru*, p. 407.

‡ *Egyptian Archæology*, by G. Maspero, p. 17.

this fortification as far back as the earliest of the dynasties. These examples are sufficient, although others might be cited, to show that mud walls need not be mere things of a day, and that they have in the past endured for centuries. There is a Devonshire saying regarding the "cob," or mud walls, of that locality, "A good hat and a good pair of shoes is all that cob wants." The pair of shoes here meant is a stone foundation such as I have described in the Persian houses; that is, to protect the lower part of the wall; and the hat is a sufficient amount of thatch, or covering, to the top of the wall to save it from the influence of rain. With such conditions, I believe that mud walls in Devon, even in our own damp climate, have stood for long periods of time.

I come now to one very interesting part of the subject connected with this peculiar style of building, and that is to point out a few architectural forms that can be traced back to it. The history of no architecture can be accepted as complete till every form in it has been followed through the past to its first origin. This has been fairly well done in Greek architecture, where the main features of it have been traced back to wooden forms. Many of the details of Egyptian and Indian architecture have also been shown to have had a similar derivation. In these details the wooden character has been so distinctly continued in the lithic reproductions, that the evidence may be considered as complete and reliable. In the material we are now dealing with, the forms are not so well defined, and the mutation from one material to another having taken place far back in their history, we have not the same trustworthy evidence to present regarding it. Yet, in some points it is fairly good, and in others we have every probability to support them.

The sloping jambs of doors and windows are peculiar to many old styles of architecture, such as the early Greek and Etruscan. Theories of origin for this have been often suggested, but we have no difficulty in accounting for them, if we suppose that the narrowness above was a form, and the natural result of the sloping walls of mud. The wooden parts of the first Greek temples were the portico and the wooden frame to support the roof; the walls of the cella were, in all probability, of crude brick. The late explorations at Olympia have led to an idea—but which still requires further support—that the cella of the Heræum at that place had been constructed of mud. This is the temple of which Pausanias states* that one of its original wooden columns still existed in his time, which is an evidence in itself of its great antiquity.

I have already explained how builders in mud—and which is well exemplified in Persia —construct their walls with a broad base, to give solidity below, and with a marked batter upwards to reduce the weight above. It has been suggested—and, I think, with every reason in its favour—that this explains the very marked slope of the perpendicular lines of the Egyptian pylons. All the authorities agree in stating that in the old temples the outer wall forming the temnos of temples of Egypt was made of crude brick, and as the pylon was the gate through this wall in front of the temple, the great probability of its being constructed of the same material is obvious.

At one time, the Romans were credited with having invented the arch. Later, it was supposed that they only derived it from the Etruscans. At the present day, no one would venture on locating the discovery of this constructive form with any one particular people or country. It is now known to be so old in Egypt, that its first beginning there cannot be determined. Vaulted and domed structures—such being principally used for granaries or storehouses—are also very ancient. The same may be said of Mesopotamia. Domed buildings are represented in a sculpture from Kouyundjik. M. Place's excavations at Nineveh show that the palaces there were roofed with vaults of crude brick, covered with stucco. Long ago, Mr. Fergusson reasoned out the probability of this from the plans of these buildings. The Chaldeans constructed vaults and domes two or three thousand years before our era; and M. de Sarzec's explorations at Tello has raised the supposition that the Proto-Chaldeans were capable of accomplishing the same kind of roofing for their houses.

When I had seen village after village in Persia with vaulted or domed roofs, and learned that such roofs could be formed without centres, the idea immediately suggested itself that these methods of building had existed from the most primitive times; and this supposition finds strong support, from the results of recent explorations in Egypt and Mesopotamia, which have just been referred to. While the necessity for wooden center-

* *Pausanias*, B. v. c. xvi.

ings for building vaults and domes was believed in, we never could have credited an early state of civilisation with this invention. Let this assumption regarding centres be removed, and the whole problem is changed. The earlier workers in mud or clay could not have been long in discovering how to spread their material over the space enclosed by four walls. They would, no doubt, have begun at first with small spaces, and a very little experience would soon have enabled them to deal with greater. If any one considers the matter, I think he must arrive at the conclusion that mud must have been first used for a long period of time before burnt-brick came into existence; and now that we know how easy it is to produce a roof with the mud, there is no great improbability in the assumption that the vault or dome, as well as the arch, all date back to a period when that material alone was in use. This also means that it was in a region where wood was scarce; for the existence of wood must have had in itself the tendency to prevent the invention of the vaulted roof. I do not suppose that the vault was invented in one region and was afterwards carried to another; my idea is, that wherever the conditions that I have described existed, such a mode of producing a roof would be arrived at. Whatever may have been the case, it occurred so far back in the history of our race that I fear the exact date is likely to remain as one we can only speculate upon. My own conclusions, which can pretend to nothing more than that of inferring what may have been probable, is at least based on our latest knowledge. Further explorations may give us more light and more certain data to reason upon.

Let me here direct attention to a very important development—in fact, to what might be called a complete change in architecture, which can be traced back to this origin of the arch, the vault, and the dome, which have been followed back to their first origin; the origin, I frankly admit, is theoretical, but it is a theory with much in its favour. Greek architecture was what is technically called "trabeate," that is, with columns supporting a lintel or architrave. This style originated from wood, and was, by means of the conquests of Greece and Rome, largely diffused over the old world. The change which occurred was that of the pier supplanting the column, of the arch doing duty for the lintel; the vaulted roof and dome at the same time taking the place of the straight lined roof and pediment. This important change in architecture, was, in fact, nothing less than the forms of mud origin supplanting those forms that had been derived from wood. The style to which this mutation is attributed is that known as the Sassanian, which belongs to the period when the dynasty of that name ruled in Mesopotamia. There are very few remains of this architecture left,* but in these few we find the arch, the vault, and the dome, combined into a full-grown architectural style. The rise of Byzantine architecture may have been independent, but it was nearly contemporaneous with the other, and was probably influenced by it. When the Mohammedans destroyed the Sassanian power, they seem to have adopted the architecture, for the arch and the dome became the principal features of the Saracenic style, which they carried westward to the shores of the Atlantic, and into Spain.

Not only did this style influence the architecture westward, but I am now in a position which enables me to trace it eastwards as well. Major Talbot, R.E., one of the officers on the Survey Department, with the Afghan Boundary Commission, chanced to visit a place called Haibak, which is on the main road from Kabul to Central Asia; it is to the eastward, and not very far distant from the site of the ancient city of Balkh. There are numerous caves in the locality, and as they are near to Bamian with its city of caverns, their Buddhist character may be assumed. Major Talbot luckily made very careful plans and sections of one group, known as the "Stables of Rustem." These he sent home to me, and on inspecting them I found that some of these caves had domes excavated in the rock, and that they were imitations of constructed domes. But more than this, I saw that the domes were the same in form as the few still remaining to represent what Sassanian architecture had been. One of the details which fully determines this, is the pendentive, by which the square form of the plan is converted into the round as the base of the dome. These are exactly the same in the Haibak caves as in the Sassanian domes. Major Talbot, by good luck, sent me a sketch of a pendentive in one of the Bamian caves, and it is similar to the others, showing that the Haibak examples were not exceptional. As these domes were exact copies of structural ones, they prove most distinctly that the Sassanian style was not limited to Mesopo-

* Among the few may be mentioned the Takht-i-Khosru at Cresiphon, and the palaces at Feruzabad and Sarvistan.

tamia, but must have extended eastward all through Persia and Khorassan to Central Asia. This discovery necessarily gives a new value to the Sassanian mode of construction, which has been known up to the present from about only half a dozen ruined monuments that have been left to us. A question is opened up by this new aspect of the case: that is, did this style first originate on the banks of the Euphrates or in Central Asia, both of them mud-building regions? This cannot be answered at present. The great probability is that it might have been contemporaneous along the whole region. Now that we know the Sassanian style existed so far east, it becomes evident that it was the architecture carried at a later date by the Mohammedans to Afghanistan and also into India, where it became the parent of the Mohammedan style in that country, and produced those beautiful musjids and tombs at Delhi and Agra, which command the admiration of all that are lucky enough to behold them.

I have described the foundations of a mud wall, such as they are in Persia, formed of burnt bricks or stones and lime; and also in Devonshire, where they are known as a "good pair of shoes," because they protect the feet, or lower part of the wall. In the remains of the temple of Viracocha in Peru the mud walls there have a stone base eight feet in height. With these examples before us, and understanding the necessary purposes they served, we may assume that such protective substructures were generally employed wherever this particular manner of building was in use. It is highly probable that in this rude constructive detail we have the first origin of that part of the architecture in the palaces of Assyria to which the great winged bulls in the British Museum belonged. It seems now to be accepted that these palaces were constructed of crude brick, or at least this material was the principal one employed; baked or perhaps glazed brick may have been used in the exterior of the walls, but the interior was of sun-dried brick, and covered with stucco. This latter part is exactly what I saw in Persia, and have already described in this paper. Along the base of these walls slabs of marble were placed, varying from three to about eight feet in height. These were generally sculptured, and the great bulls were represented on the portions of the slabs on each side of the doors. The development of this highly ornamental dado in the palace, from the base of the mud wall, is not a difficult problem to solve. The foundations I saw in the villages were formed of stones, half-bricks, or rubbish of any kind. In the better class of houses a more regular construction would be followed; and in palaces the covering of this with marble is what might be expected. I accompanied a visit of ceremony to the palace of one of the Shah's sons in Tehran, and I noticed that, in the room where we were received, slabs of alabaster, about three feet in height, went all round the base of the walls. These alabaster slabs in Persia are the counter-part of the marbles in the palaces of Assyria. In both cases they served the same purpose—they protected the lower part of the walls.

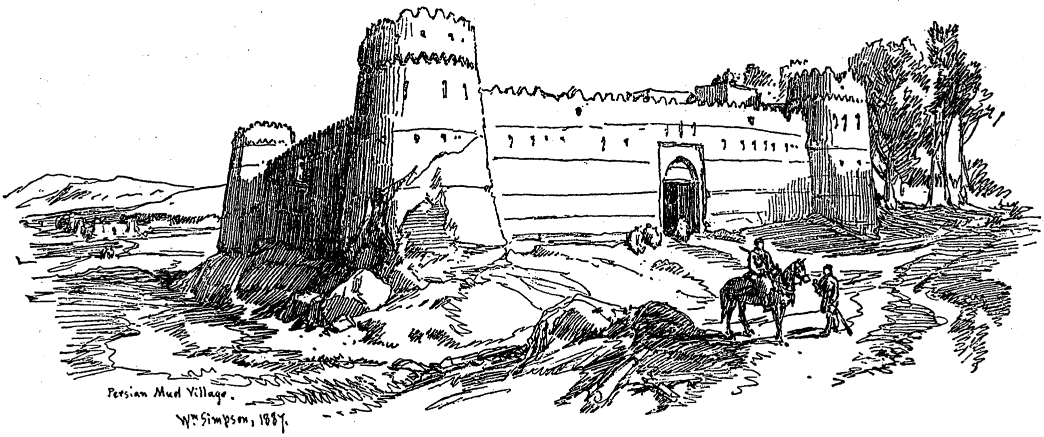
It is not so long ago, in this country, that the dado commanded a large amount of what, at the time, was known as æsthetic devotion. From the interest then produced, I feel justified in pointing out that here I have given the origin of at least one dado, and that a very important one, as the sculptures in the British Museum make evident.

I am inclined to suppose that the old masonry which we recognise under the word "cyclopean," which is known to all who have any familiarity with the archæology of Greece, had its first origin as the base of mud walls. No direct evidence exists on which to ground this supposition, and I only present it here as a mere guess. We do know that Greek towns were, at an early period, defended by mud walls. In B.C. 385, Agesipolis, King of the Spartans, managed to take the city of Mantinea, by damming up the river till its waters reached the base of the mud walls, which fell down as soon as their lower part was softened. Pausanias, writing of this siege, declares that such walls were, in one respect, better than stone:—"Though a wall of this kind," he says, "stands the shock of warlike engines, and is a better defence than a wall of stone [for stones are broken in pieces, and leap from their places, through the force of these engines], yet it is dissolved by water no less than wax, by the sun."* As an evidence that mud walls of cities in ancient Greece were not exceptional, Pausanius may again be quoted. He says that, regarding the method by which Mantinea fell, that "Agesipolis was not the inventor of this stratagem; but it was employed prior to him by Cimon, the son of Miltiades, when he besieged Eion, near the river Strymon."† These references show, not

* *Pausanias* b. viii. c. xviii. † *Ibid.*

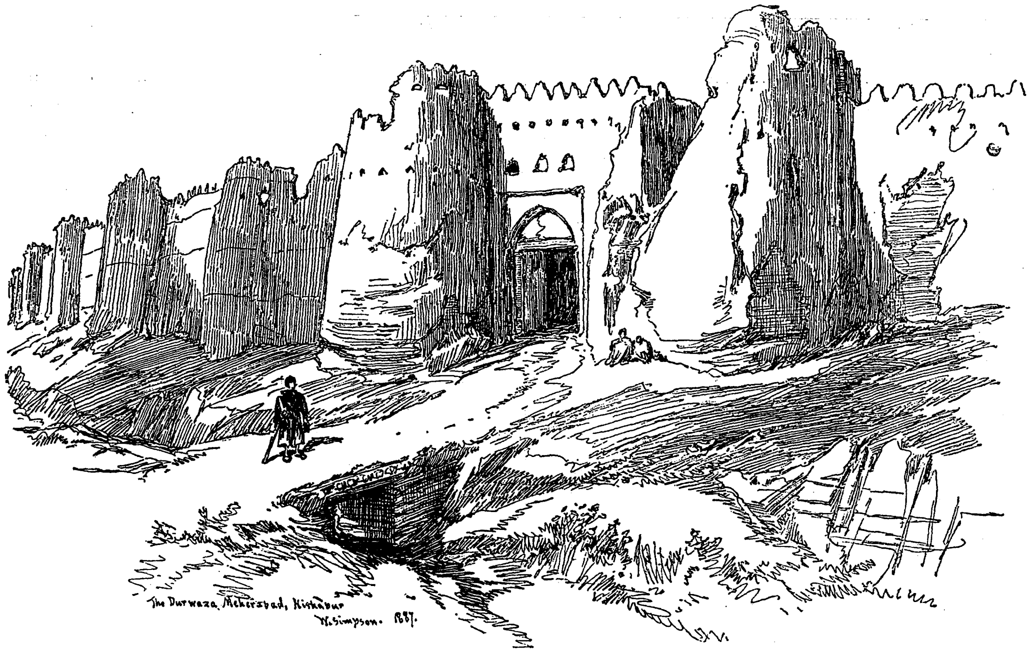
only that mud walls were common, but that, for security, a "good pair of shoes" was an absolute necessity in that early period, when Cyclopean masonry was practised. This suggestion first occurred to me from Squier's description of the Temple of Viracocha, where the old wall of *adobes* stands on a base of Cyclopean masonry 8 feet high and $5\frac{1}{2}$ feet thick. An illustration is given, which shows the exact character of the masonry.

FIG. 4.



PERSIAN MUD VILLAGE.

FIG. 5.



THE MUD WALLS OF NISHAPUR, KHORASSAN.

It was a source of some surprise to me to find that the Persian villages were, as a rule, exactly similar to those I had seen in the Khyber Pass and other parts of Afghanistan. They are square, formed with four high crenelated walls, and a round tower at each corner. The gateway is in the centre of one of the walls, and the mud houses are huddled together inside, one might say, "anyhow." Larger villages may have six or eight towers; small towns or large ones have more wall, and a larger number of towers. One of the first

things that drew my attention to mud as a building material in Persia was, when in passing a small town one morning on the march, I saw some men either building or repairing the walls and towers of the place. It then struck me that these defensive walls were, with only some trifling details of difference, almost identical with the walls we are so familiar with on the Assyrian sculptures. There is the same repetition of crenelated wall and tower, and constructed of the same material. I said to myself "these men, in the present day, are building an old Assyrian wall of fortification." Such defences must have begun at a very early date in Mesopotamia, long before the sculptures were produced from which we know what they were in appearance, and their construction has never ceased from that to our own time. This presents a very striking illustration of the continuity of type; and I confess that the discovery produced at the moment a very strong impression upon my own mind.

About one hundred miles east of Tehran there is a curious village called Lasgird* (Fig. 6). It is supposed to be very old, and its circular plan is said to have been first drawn on the ground by Las, the son of Noah. Not having heard of this personage before, I have been looking out for some reference to this member of Noah's family, but up to the present without success. The statement has already been made that the villages in Persia are square; such is the rule, and it will explain so far how a round one in their midst appears as something strange and remarkable. Imagine a huge rough cylinder of mud standing up, perhaps 30 feet or more in height, and covering a space about the size of that enclosed by the railings of Liecester-square. (These are only eye guesses as to dimensions). This great circular wall is so massive, that the houses of the people are constructed on the top of it, and form in a rather irregular manner two storeys. There are rude balconies, or I ought to say narrow ledges, on the outside which form communications. These are made of untrimmed branches of trees interlaced with twigs, on which mud is laid, but without a protective railing of any kind. Goats which I saw on these frail and dilapidated ledges were safe enough; but children, that I also noticed at play on them, seemed doomed sooner or later to certain destruction. The interior space formed by the circular wall is filled with store rooms and places where the cattle can be safely housed in case of an attack from the Turkomans. The only entrance into this strange structure is by a small opening about 4 feet by 3, which can be closed by a stone door turning on pivots. The smallness of this doorway was intended to prevent raiding enemies from entering during the chances of a rush, for it would be necessary to keep it open to the last moment to admit those of the villagers who were running home for protection. I noticed small stone doors in many places, and the purpose they served was that they could not be destroyed by fire;* the raiders had no time for regular siege operations. They made a rush upon a village, and caught all, man or beast, that were unlucky enough to fail in reaching the shelter of their mud walls.

I have dealt with this building material in the past; regarding its future I can say but little. In England here it was largely in use, so was wood, and that which is well expressed by the words "wattle and dab," which might be described as a combination of wood and mud. All these, as our material conditions have improved, have been slowly supplanted by the burnt brick or stone. "Cob" is still in use, to a limited extent only, in north Devon. It may be assumed that it is not suited for our damp climate. In dry climates, such as Persia and Egypt, it is likely to continue, for the simple reasons that it is a cheap material, and that a comfortable dwelling can be made from it. It might be utilised by some of our emigrants. Australia is reputed to be a dry country, and it might be employed by first settlers, particularly where wood is scarce. An emigrant, if he had a few hints and suggestions to start with, could easily construct a house for himself, and it would have one great advantage over a wooden house—it could not be burnt down. I have already mentioned in this paper how an officer at Jellalabad made a very comfortable hut for himself. What he did there an emigrant might easily do in Australia. The non-inflammable character of mud ought to be a strong recommendation to it in many parts of the

* *Gird* in this word is said to have the same signification as "girdle" in English—which may be rendered as "circle." [This block has been kindly lent by the Editor of the *Illustrated London News*.]

* The stone doors which are found so plentiful in the Hauran are formed after a wooden model, implying that wood had been the material at one time. The purpose of the stone doors in Persia makes it probable that a change at one period had taken place in the Hauran: unsettled times had come, and the doors had to be changed from wood to stone, to prevent burning, and thus give safety from sudden attacks.

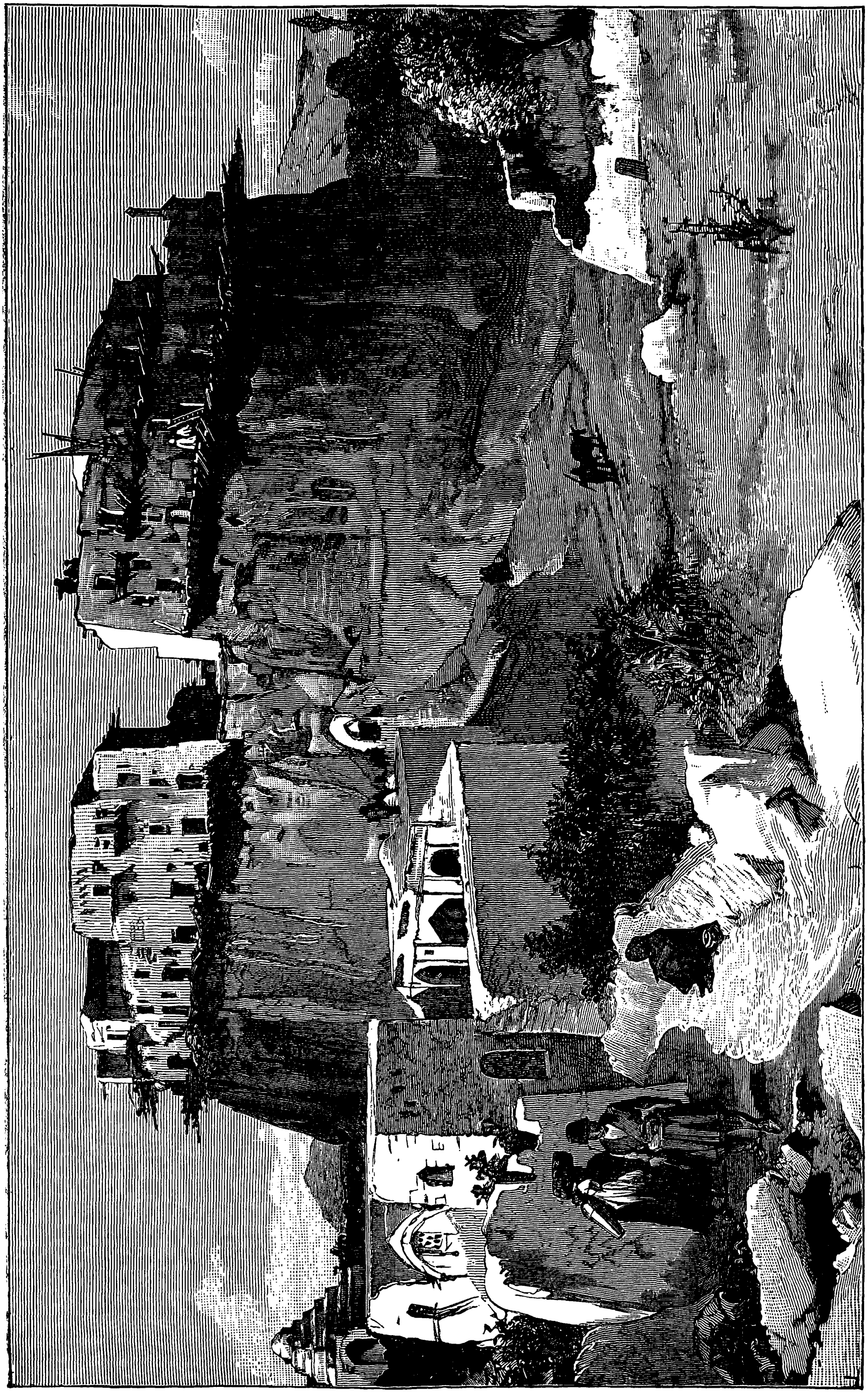


Fig. 6.—Lasgird.

country. I might mention a country like California as one where this material might be valuable. California has a dry climate. When I was in San Francisco, in 1873, that town was almost wholly constructed of wood. Stone was feared owing to the chances of earthquakes. While there, I visited the Church of St. Francis, built of *adobes* a century before, and it had stood firm and secure all that time. It occurs to me—but I

FIG. 7.

STONE DOOR, LASGIRD.

have no right to speak as an expert—that a house built of thick mud walls and wooden joists and rafters, would be tolerably safe during an earthquake, unless it was a very severe shock; such a house would also be safer than a wooden one from fire, which has always been a great danger in San Francisco. I have only referred to California as an example; what has been said of it will apply to many other parts of the world, where it is possible this building material might be used with advantage even in our own day.

DISCUSSION.

Mr. H. STANNUS said when the subject appeared on the paper, many might not exactly see the connection between mud architecture and applied art, but, after listening to the paper, they would be of opinion that mud, as used in the dwelling of man, was applied art. All arts had arisen from the three necessities of man, viz., food, clothing, and shelter; and mud architecture had been exceedingly useful to the shelter of man, protecting him from heat of the sun, from cold, and from fire, though, he was afraid, not from damp. During the reading of the early part of the paper he had been reminded of the early Assyrian times; and bearing in mind how Assyria, in the upper part, and Babylonia, in the lower part, of Mesopotamia, were both watered by the two rivers, and by their innumerable affluents, which flowed down from the mountain of Armenia, it would be easily understood that mud must be the material used for building. Builders who had not convenience for transportation must use the local material. Obviously Mesopotamia, being an alluvial plain, consisting of the mud brought down by the rivers, would supply this. The books on Assyrian art show how the commencement of the king's palace, or the village which contained the group of palaces, was the heaping-up of a platform from 20 to 40 feet above the plain. This platform had great value for several reasons; in the first place it protected the people from flood; in the next place it protected them from the mists which settled down in alluvial valleys; and it was moreover a protection against enemies. Very early in the history of the human race the tower of Babel was built for some of these reasons. The people of that country were great star-gazers, and obviously any platform which lifted them above the mists into the clearer atmosphere, would be of great advantage. We had been much interested in the statement as to the origin of the door-jambs. Mr. Simpson had not quoted, though he must have known, the instances of buildings with architectural pretensions in Persia in which columns and door-jambs still remained, but without any wall remaining between the jamb and the column; the probability being that the door-jambs were placed there to get the true sharp angle, the intervening space being filled with mud. A wall has two duties to perform: to support and to enclose. The portion which was a door-jamb, or buttress, or pilaster, supported the beam; and that portion which was the plain wall, served the part of a curtain, and merely enclosed. It was therefore exceedingly likely that the door-jambs were first built, and then the curtain of mud was placed between to serve the enclosing function of the wall. With regard to the statement that it was necessary for mud to have a "good pair of shoes," it seemed to him that the same thought must have occurred to the Assyrians who used slabs to protect the walls. There was no doubt that the "dado" had its origin in the earlier Assyrian prototypes. As to the suggestion that mud might be utilised for building purposes in Australia, he might observe that it was a necessity that the soil should be clayey, otherwise it would not hold together. If the soil were sandy, he supposed the reader of the paper would qualify the suggestion to that extent.

Mr. T. CHRISTY said that, having lived in China for some time, he had been much struck with the fact that in the construction of large Chinese houses a tier of stonework was invariably used. In many of the large temples they would not even go to the trouble of building entirely with mud, but they got a curved tile made from mud, burnt or baked—if they could afford straw they burnt them a little more—and the space between the tiles was filled with mud. This mud was obtained from the sluggish rivers, and consisted of a sort of ooze from the banks, which was plastered into the walls, as they found the vegetable matter was so much more advantageous than the ordinary clay which was found in the fields. Slabs were placed in front of the houses, like a dado, to protect the walls from injury. The Chinese always took care that the houses faced in the "proper direction," and the eaves were used for storing dried poultry under for winter consumption. No doubt Mr. Simpson would remember that when he visited Siam he found very much the same system of architecture had been employed in the construction of the temples. He thought the paper had cleared up an important missing link in connection with architecture.

Mr. MARTIN WOOD did not know whether he ought to find fault with the title of the paper, seeing that the first part of it related more to bricks than to mud. He should be glad to know whether Mr. Simpson was clear upon the point that the use of mud in Mesopotamia was due to the want of timber; for he had always been accustomed to suppose that those regions, now so arid and bare, were at one time tolerably well wooded. He should also be glad to know whether Mr. Simpson could give any explanation as to the difference between a fire-burnt brick and a sun-burnt brick, and the degree of protection they afforded from the sun. He knew that when the palatial barracks at Allahabad were found uninhabitable because of the heat, a Commission was appointed to inquire into this subject; and Lord Napier, who was upon the Commission, insisted on some of the arches being filled up with sun-dried bricks. The paper had developed a more practical side than he anticipated, for it not only dealt with the past, but also the future. He thought if a large part of the soil of Australia were sandy, the suggestion thrown out in the paper could not be adopted. But his own impression was that there was a large amount of alluvial soil in Australia. The suggestion as to countries where earthquakes were prevalent was, to his mind, an exceedingly good

one. As to mud supplanting wooden-built houses in California, he thought this point was one which ought to be strongly urged by way of checking the destruction of timber on the Pacific slope.

Mr. SCOTT MORTON said, like his friend Mr. Stannus, he was a member of a guild in which applied art was a very important subject, and he did not see how a paper on mud could assist them much on matters appertaining to building. Such methods of building in this country must be of very limited application, owing to the small amount of sunshine. In Eastern climes the sun was a very important factor in hardening the mud. One great drawback to the use of mud in this country was frost, for mud, if exposed for a short time to frost, became useless for walls. He thought it would be extremely interesting to shut Mr. Simpson in a room and get him to use his wonderfully facile pencil and colour brush, so as to give them an insight into what he had seen during his travels, in those combinations of mud and tiles to which he referred. If he was in possession of any drawings, he hoped that on a future occasion he would give those interested in this subject an opportunity of looking at them. No doubt Mr. Simpson could show them the application of stamping the mud, which subject was a very wide one, the range being practically unlimited. The subject of foundations, too, which had been referred to, was certainly a very interesting one. While speaking of Mesopotamia, a Scriptural reference passed through his mind, which was to be found in the book of Ezekiel, of people who built temporary mud dwellings, and a reference to floods coming and hailstorms. When they considered that many of those great plains in the rainy season were flooded, they could understand the value of foundations for erecting mud buildings upon. In Africa the natives raised their dwellings on posts, in order to avoid danger from the flooding, as well as to get free of vermin. A great deal had been said as to the construction of arches and domes without centering, and about the skill of the people in constructing these, and this certainly opened up a very interesting subject of inquiry. In constructing a dome, the first course was laid simultaneously; and started on the principle of an arch upwards and inwards. This course would support itself, and if a little notch were made in the next course, it would rest on the first, and so the dome could be constructed without centering.

Mr. H. LONGDEN said it was very charming to hear that mud buildings were decorated with a product of mud, viz., tiles which were merely burnt earth. This seemed a special example of the fitness in things. To his mind, Persian tiles were the most beautiful that were ever made. If anyone wished to get the finest colouring in tiles, they must look to Persia as the origin of their colouring, and most probably for design also. He thought the paper a most interesting one, as it had opened up many side views which he had not expected.

Miss WEBSTER said it might interest the meeting to hear that within her recollection two cottages had been built by settlers, on the borders of the New Forest, entirely of mud. Reading Abbey was also built of a greyish kind of earth intermixed with small pebbles.

The CHAIRMAN thought the use of mud, as a building material, was properly connected with the Applied Art Section. Having had considerable experience in mud buildings, and seen mud building by others, he knew the great importance of the material under certain circumstances, and he thought Mr. Simpson had rightly drawn attention to this, that primitive building differs in different places, according to the material available. Mud, as we understand it, is readily applicable to the little round cell, cottage, hut, or whatever we may call it. Built in a beehive shape, it was similar in point of construction to the houses built by the Esquimaux with snow. So in primitive countries, where timber was very scarce, or not to be had at all, mud was a natural and convenient kind of material to use. Mr. Simpson had noticed the construction of mud domes without centering. A dome, being built in horizontal courses, does not need the support that an arch requires. Writers on dome construction generally noticed that it does not need centering. The expression, quoted by Mr. Simpson, from Messrs. Perrot and Chipiez, describing a vault "launched into mid air," is a little inaccurate. The kind of earthen wall mentioned by Mr. Simpson, and commonly called *pisé*, made by ramming powdered clay between boarded sides, differs from mud work, in being made of dry earth. The sloping jambs of doors and windows gave a great appearance of strength to the building. Mr. Simpson was no doubt familiar with this construction, both in Egypt, and in old buildings of the Patan period at Delhi. A quotation was made in the paper from an ancient writer as to the superiority of mud over masonry in defensive fortresses, and the same advantage is gained by the use of earthwork in modern fortification, in which stone walls are not exposed but concealed by earthworks. In India, mud forts had been well known for many generations, and are very strong. The villagers in North India, when building a wall, did not always make the mud into bricks, but used large lumps, and laid them one on top of the other.

The vote of thanks having been put by the Chairman, was carried unanimously.

Mr. SIMPSON said, with regard to the remarks of Mr. Stannus, he might say, there was stone in Mesopotamia, but wood had to come from a very long distance. Strabo is the authority for the scarcity of wood in that country, which, no doubt, obliged the natives to build barrelled roofs, as

he had already stated. Mr. Christy's remarks as to the mode in which the Chinese built their houses was interesting to him, because, when he was in China, he did not chance to see any mud buildings, and, on that account, he could add nothing to what Mr. Christy had said about the Chinese. He regretted to say that he was unable to answer the question put by Mr. Martin Wood, as to the difference between the two kinds of bricks as a protection against the sun. Sun-dried bricks were not generally stamped, and the only place he had seen stamped bricks was in Bengal; but there were, of course, fire-burnt bricks.

Miscellaneous.

THE WOOL INDUSTRY OF THE PUNJAB.

The United States Consul-General at Calcutta, in a recent report to his Government, states that the Punjab, with its 6,551,180 sheep and its 83,000 maunds of wool, annually made into shawls, carpets, blankets, &c., holds an important place in the sheep and wool industry. Shearing in the Punjab is done twice a year generally, though, in a few of the districts, there is an intermediate shearing in June. The wages paid consist of one-twentieth of the wool shorn. A man can shear twenty unwashed and twenty-five washed sheep in a day. Wool sorting in the Punjab is done in a very primitive style, and in some parts it is not done at all. Washing of the wool is not common, nor is it very necessary, except in the case of wool loaded with sticky matter. Unless done carefully, and with suitable soap, it is very bad for the wool, and picking by hand or some other process is, in every case, still necessary for the removal of burrs, thorns, seeds, &c., which are entangled in the fibres. The picking out by hand of foreign bodies is done everywhere. It is a very tedious process in the case of wool grown in places abounding in thorny bushes and undergrowth, and the workers are nearly always women. The mere process of hand-picking involves a certain amount of teasing out of matted portions of wool; but where scutching and combing are uncommon—a state of affairs which appears to exist in the Jung district, and in Jullinder and Ludhiana—something more than this is necessary. The wool must be reduced by hand to a mass of fluff; but to effect this, in most districts, either the *pinjan* (bowstring) or the comb is used. A bow is suspended, string downwards, at such a height that the string passes through the wool to be operated upon. The string is then made to vibrate violently, either by twitching it or by striking it with a hammer, and the vibrating string catches up and scatters the wool about. The instrument is used in nearly every district of the Punjab, and nearly everywhere the work is done by men of some low caste. In most places there is a separate caste of *pinjas*. The bowstring and the comb are not merely alternate instruments for effecting the same purpose: the former opens out the wool and loosens its mass, bnt leaves the fibres lying confusedly in all directions; the latter tends to open the wool, and also to lay the fibres side by side in parallel lines. The former is used when woollen thread is wanted, the latter when the spinning of worsted is the object. The combs used in the Punjab are of two sorts, single and double. The double are reported to be used only in Gujurn-walla, Amritsir, and Lahore, and the single comb is found in Sialkot and the Ferozepoor. The double comb (*shana kanga*), which is the more effective of the two, consists of a piece of wood laid on the ground, with two parallel rows of vertical iron teeth standing on it, there being twenty teeth, about four inches high, and the intervals between the two rows and between the teeth being one inch and one-half an inch respectively. The teeth are rigidly fixed to the platform, which is kept steady by the operator's feet. He does the combing by taking a flock of wool, striking it upon the teeth, and drawing it gently downwards through the teeth at right angles to the rows. The single comb is a very primitive instrument, and has very imperfect effects. In its rudest form, it is a mere *panja*, or claw, which cleans rather than combs. Neither the single nor the double instrument is used for combing short stapled wool, nor could it be employed with any effect for such a purpose. The wool, when teased, or scratched, or combed, as the case may be, is made up into balls (*punis*). The next operation is spinning. The *charkhi* is formed of two parallel discs, the circumferences of which are connected by threads, and over the drum so formed passes a driving band, also made of thread, which communicates a rapid motion to the axis of the spindle. The end of a *puni* is presented to the point of the spindle, which seizes the fibre and spins a thread, the *puni* being drawn away, as the thread forms, as far as the spinner's arm will reach. The thread is then slackened, and allowed to coil itself on the body of the spindle until the latter is full, when it is removed. In some parts, notably in Cooloo, the *charkhi* is quite unknown, and the instrument used is the *dherna*, or *takli*, a pointed instrument, similar to the unattached spindle of an old-fashioned spinning wheel, with a disc at the blunt end. A portion of a *puni* is drawn out and held to the upper part of the instrument, and wound round it. The *dherna* is then spun round in the hand, and when it has got firm hold of the wool, it is allowed to hang in the air suspended by the thread it is spinning, the right hand of the operator keeping up the rotary motion, while the left hand regulates the draft of the wool. When the thread is getting so long as to put the *dherna* out of reach or to let it touch the ground, the draft of wool from the *puni* is stopped, and the piece that has been spun is wound

on the *dherna*. The *charkhi* is said to produce a more even and reliable thread than the *dherna*, owing to the greater regularity of the rotatory motion in the former machine. In the hills spinning is done by all classes of both sexes and all ages, from ten years and upwards. Consul Merrill says that, in Cooloo, every tenth person met on the road is spinning wool with a *takli*, as he or she walks along, and it is no doubt the portability of the instrument, as much as anything else, that causes it to be used instead of the *charkhi*. When yarn has been spun, it is generally found that it is too thin, in places, to bear the strain of weaving, or when a coarse thick fabric is required. The yarn has, therefore, to be doubled or trebled, and sometimes more than three folds are given. For twisting, as this process is called, the *charkhi* can be used, and also a form (called *masan*) of the *dherna* or *takli*, the difference being that the upper end of the spindle has a narrow, curved groove, about half an inch long, running from the point along and round the rod, and in this groove the threads, twisted together, are run. Yarn, single or double, is sold in the hills, in balls or on reels of various shapes; but, before weaving, it must be wound on reels, and the warp prepared. Two reels are fixed at the end of sticks on a pivot, on which they can revolve. A double row of sticks or reels is then planted on the ground, at intervals of about two yards, extending either in a straight line or in a loop to the length which the piece of cloth is to have. The warp-layer then takes a stick and reels in each hand, and walks along the line, dropping the threads, one inside and the other outside the sticks alternately, so that the two cross each other between each pair. Having got to the end of the line, the operator returns in the same way, and so on, up and down, until enough threads have been laid to make the required width of the fabric. If the cloth is to have a longitudinal stripe or a check, reels of different colours are used, and the proper number of threads laid on with each colour. Some of the wool used in the Punjab is brought from Beloochistan, where the pasturage is peculiar, and from Cashmere, where the water is said to contain valuable qualities. Thousands of the inhabitants of Cashmere, in the last 50 years, have come over from their native valley to settle in the Punjab, and, encouraged and assisted by European agents, have engaged in the manufacture of shawls.

MEXICAN SILK INDUSTRY.

The *Moniteur des Soies* says that Mexico is well adapted to the culture of the mulberry and to the rearing of the silkworm, owing to its excellent climatic conditions. In this country every variety of climate is found—in certain regions a mild and equable temperature all the year round, and in others severe cold. The idea of cultivating the silkworm first originated in the minds of some Spanish monks, who had visited the extreme East and found, on returning to Mexico, that it was as suitable for this industry as China itself, and they planted mulberry trees in considerable numbers. After a time these plantations were neglected, until M. Chambon, a Frenchman from the Ardèche, assisted by the Mexican Government, took them in hand. He also distributed silkworms eggs of the best quality, and taught the Indians the best methods of rearing the worms. Mulberry plants were then brought from France, chiefly from the departments of the Ardèche, Vaucluse, and Isère, and five millions of these young trees were planted in the States of Puebla, Mexico, Guanajuato, and Jalisco. The greatest advantage that the Mexican silk grower has over his Chinese and European rivals is due to the complete renewal of his mulberry plantations; for, in this country, the trees are young, well selected, and spaced out in lands costing only a nominal sum. In addition, the Mexican grower, having everything to learn, only devotes himself to the modern scientific aspect of the question, and is not hampered by tradition or routine. Practical schools of sericulture under the direction of M. Chambon have been established in several States, many having already been opened at Guadalaxara, and throughout the State of Jalisco, at Léon, Morelia, Puebla, and Toluca, and in the environs of Mexico at Mixcoac, Texcoco, &c. Others are shortly to be opened in the north, and in the south at Oaxaca and Monterey. It has been found that the yield from an ounce of seed is from forty-five to fifty kilogrammes of cocoons (kilogramme=2·2 lbs. avoirdupois), that is from ten to fifteen kilogrammes more than the average French yield. This average, it is stated, can be increased, and in that ease it would exceed the yield in the best districts of Italy and Austria. The President of the Mexican Republic, General Porfirio Diaz, obtained from a trial on his estate at Oaxaca, 200 kilogrammes of cocoons with three ounces of seed, or a yield of sixty-seven kilogrammes to the ounce. The Governor of Jalisco has given every assistance to the development of the silk industry in that State, and in view of the fact that the Mexican women exercise considerable care and patience in tending the silkworms, that the mulberry trees grow in this country three times as quickly as they do in Europe, and that the weaving of silk can be effected at home at a trifling cost, there is every reason to believe that in a few years Mexico will hold a good place among silk-exporting countries. The proximity of the United States is an inducement to Mexico to become a silk-producing country, as unbleached silk is admitted free into the United States, while European tissues are practically excluded. The rapidity with which the industry of silk weaving in the United States is developing, coincident with the almost complete failure of sericulture, opens a vast field to the Mexican grower. For some time past small factories for reeling and twisting silk hair existed in Mexico, and in the city of Mexico a factory has been established to which dye

works have been added. In this factory there are six Jacquard looms for the manufacture of silk *rebozos* (wide silken scarves much worn by the Mexicans). Other factories for the manufacture of *rebozos* have been established in the country, particularly at Purbla and San Luis Potosi. The amount of silk annually worked up may be estimated at £30,000. The organsine is used for the manufacture of *rebozos*, and the weft silk, at Mexico and Monterey, for making up passementerie and hats, and for upholstering purposes. The manufacture of galloons is assuming considerable importance in Mexico, and scarcely any of these articles are now imported.

TABLET, OR COMPRESSED TEA.

Brick tea has usually but little to commend it, as it is known to be composed of the sweepings and dust of the Chinese tea factories. Its chief market is Russia, which took from China last year 2,005,548 lbs., one half the usual export, due, it is said, to the scarcity of tea dust. A new article in tea has, however, recently sprung up in China, in the form of tablet tea, which appeared in the trade returns of Kiukiang for the first time last year, machinery having been erected there for its manufacture, and the quantity shipped from that port was 493,392 lbs. Tablet tea is made from the very best quality of tea dust. It is formed, by pressure alone, into small cakes, which are perfectly hard and solid, and somewhat resemble chocolate in appearance. The material is not, like brick tea, moistened with steam, before being compressed, and the flavour is not in any way impaired by the process of manufacture. As it takes up little space, and is most unlikely to get spoilt or damaged, it is recommended as a convenient form of tea for travellers, backwoodsmen, or armies in the field. With these conveniences, and a guaranteed good quality, there is no reason why tablet, or compressed tea, should not become generally used.

Obituary.

PETER WILLIAM WILLANS.—On Monday, 23rd May, Mr. Willans, the well-known engineer, was thrown from his dog-cart, when his skull was fractured, and from this accident he died shortly afterwards. The following particulars of his life are obtained from *Engineering* :—Peter William Willans was born in November, 1851, at Leeds, Yorkshire, and was educated at the public grammar school of that town. He served his apprenticeship with the firm of Carrett and Marshall, afterwards known as Hathorn, Campbell, and Davey, and in August, 1872, he entered the employment of Messrs. John Penn and Sons, of Greenwich, where, after working for a few years in the drawing office, he first brought out his patent three-cylinder engine. On leaving Messrs. Penn's he for some time acted as consulting engineer with Mr. A. Ward, as Willans and Ward, but he soon afterwards became associated with Messrs. Hunter and English, of Bow, who took up the manufacture of the Willans engine for marine purposes; eventually, however, as he was then living near Kingston-on-Thames, he, about thirteen years ago, started works on his own account in partnership with Mr. Mark H. Robinson, at Thames Ditton. Here he brought out the two-cylinder central valve engine, which is so much used for electric lighting, and which has made his name so deservedly famous in every part of the country. Mr. Willans's family had for several generations taken a leading part in the cloth trade in Leeds, and as his father owned some large mills, it was always intended that the son, the subject of this notice, should be brought up in the woollen business; but through the persuasion of Mr. W. H. Massey, an old schoolfellow, he became an engineer. Mr. Willans was elected a member of the Society of Arts in 1888, and so lately as May 4 he joined in the discussion on Mr. Shoolbred's paper on "The Bradford Corporation Electricity Supply."

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 7 ... Royal Institution, Albemarle-street, 3 p.m. Prof. R. C. Jebb, "Some Aspects of Greek Poetry." (Lecture III.)
Photographic, 5A, Pall-mall East, S.W., 8 p.m.

WEDNESDAY, JUNE 8 ... Geological, Burlington-house, W., 8 p.m. 1. Mr. R. J. Lechmere Guppy, "The Tertiary Microzoic Formations of Trinidad (West Indies)." 2. Rev. A. Irving, "The Bagshot Beds of Bagshot Heath (a Rejoinder)." 3. Johnson Pasha and Mr. H. D. Drummond, "Notes on the Geology of the Nile Valley."
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.
United Service Institute, Whitehall-yard, S.W., 3 p.m. Capt. W. H. James, "Magazine Rifles: their latest Development and Effects."

THURSDAY, JUNE 9...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. G. Moulton, "Faust." (Lecture III.)
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JUNE 10...United Service Institution, Whitehall-yard, S.W., 3 p.m. Mr. J. Furley, "Ambulance Work and Material in Peace and War."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Magnetic Properties of Liquid Oxygen."
Astronomical, Burlington-house, W., 8 p.m.
Institute of Brewing, Chemical Society Rooms, Burlington-house, Piccadilly, W., 8 p.m. Dr. Walter J. Sykes, "Mashing and Fermenting from a Distiller's point of view."
Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Dr. J. H. Gladstone and Mr. Hibbert, "Some points connected with the Electro-motive Zone of Secondary Batteries." 2. Prof. W. E. Ayrton and Mr. Mather, "Workshop Ballistic and other Shielded Galvanometers."

SATURDAY, JUNE 11...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 8 p.m. Prof. H. Marshall Ward, "Some Modern Discoveries in Agricultural and Forest Botany."

Journal of the Society of Arts.

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FRIDAY, JUNE 10, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 29th, at 9 p.m.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. No tickets will be sold.

The cards will be issued shortly, and further particulars as to arrangements will be announced in future numbers of the *Journal.*

Chicago Exhibition, 1893.

TRANSPORTATION COMMITTEE.

A meeting of the Transportation Committee was held on Thursday, 2nd inst. Present:—Sir Douglas Galton, K.C.B., D.C.L., F.R.S. (Chairman), Sir Nathaniel Barnaby, K.C.B., Henry Chapman, James Dredge, Francis Elgar, LL.D., Walter H. Harris, George Norgate Hooper, with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

ELECTRICAL COMMITTEE.

A meeting of the Committee for Electricity was held on Friday, June 3rd. Present:—William Henry Preece, F.R.S. (Chairman), Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Prof. W. Grylls Adams, M.A., D.Sc., F.R.S., R. E. B. Crompton, Henry Graham Harris, David Edward Hughes, F.R.S., Gisbert Kapp, W. M. Mordey, Hon. Charles A. Parsons, John Perry, D.Sc., F.R.S., C. E. Spagnoletti, Prof. Silvanus P. Thompson, D.Sc., F.R.S., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

FINE ARTS COMMITTEE.

A meeting of the Committee for Fine Arts, was held on Tuesday, 7th inst. Present:—Sir Frederick Leighton, Bart., P.R.A. (Chairman); Wyke Bayliss, Pres.R.S. Brit. Artists, Philip H. Calderon, R.A., Sir James D. Linton, P.R.I., H. Stacy Marks, R.A., Deputy-President R.S.P.W.C., Walter W. Ouless, R.A., Marcus Stone, R.A., W. Hamo Thornycroft, R.A., Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 19, 1892; Sir Charles Bernard, K.C.S.I., in chair.

The Chairman apologised for the absence of Mr. Baines, who had not yet arrived in England.

The paper read was—

THE ADMINISTRATION OF THE IMPERIAL CENSUS OF 1891 IN INDIA.

By Jervoise Athelstane Baines, I.C.S.,
Chief Census Commissioner for India.

Whilst preparing this paper, in India, one of the main difficulties that met me at the outset, not to count the proverbial first step, was, what was the extent of acquaintance with census operations in general, and of those in India in particular—and, indeed, with the circumstances of India at all—that I might assume to be possessed by an audience which I now address for the first time. I am conscious, on the one hand, that toiling incessantly for several months at one subject, and that a wide one, complicated with varied and voluminous detail, one's mind is apt to become subdued, like the dyer's hand, to that it works in. Thus, one begins to suppose that topics handled every day by oneself are equally familiar to others not under this necessity. On the other hand, there are probably many amongst you who know more than I am able to tell about India and its administration, and of such I crave indulgence for introducing, from time to time, information which must be trite and commonplace to them, but which helps, I hope, to explain to the rest the peculiarities of census-taking in circumstances

so widely different from those of the United Kingdom, or any other European country.

With these introductory remarks, I proceed at once to my subject by pointing out that a census, even reduced to its simplest form, that of the mere enumeration of the population by head, is far more necessary in India than in countries more advanced in that collection of attributes which we call civilisation. Without this operation there is no standard whereby we can periodically measure the growth, decrease, and migration or what is generally known, comprehensively, as the movement of the population. Every country presents special features in this movement, which for reasons political or social, it is incumbent upon the administration to watch most carefully. In some it is emigration, as in the German Empire, Italy, and Ireland. In others, for instance, Canada and the United States, the influence of foreign-born population, and in the latter, the gradual shifting also of the burden of the land from the East towards the West, and the growth of certain classes amongst the native-born themselves. In England, as we are all aware, one of the foremost questions of the day is the gradual accretion to the urban populations and the depletion of the purely agricultural tracts, facts which, were it not for a census, would be left but partially appreciated, and possibly, therefore, subjected to inadequate remedies. It may be urged, of course, that the registration of births, deaths, emigration and immigration, gives a sufficiently accurate view of the movement of the population to render a special enumeration superfluous, but, unfortunately, in no country has registration hitherto reached this pitch of completeness. In the United Kingdom, as a whole, the calculated population rose very materially above the figure actually found at last census, and for local purposes the error is generally so great as to render the calculation of little practical value. In India, I may remark in passing, registration of births specially is so imperfect, even in many of the large towns, that except in one or two provinces, little or no attempt is made to utilise the returns in calculating an annual rate of what is known as the "normal" increase, the excess, that is of births over deaths. The administration is, therefore, able, during the intercensal period, to perceive, but not to measure or appreciate, any special movement in the population, and the natural growth is barely even noticed.

The census, then, being one of the touchstones of the administration, and the only true means of measuring the movement of the population, the question naturally arises, how often should it be applied? The obvious answer is, at the intervals indicated by the conditions of the country, and not in accordance with any hard and fast rule. Practice varies between an interval of five and one of ten years, the decimal system having its conventional advantages. In an old country filling up very fast, or, at all events, with a brisk movement, as in Germany, or a peculiar one as in France, the shorter period is likely to be the more useful. In a country like the United States, for instance, where the population has lots of room to grow in, and, I may add, in my opinion, in India also, a ten years' interval is not excessive. For the United Kingdom, the opinion of experts in economical and vital statistics is in favour of the shorter period. This last, too, was the one adopted by the ancient Romans; but, then, that eminently practical, though overquoted, people were not content with the mere heads and so on, but made their census returns one of property in land, and beeves as well as slaves and other chattels, and on this the owner's assessment was based for the succeeding five years. The connection between enumeration and subsequent taxation, which has long been, and probably still is, a cardinal notion amongst the people of India, has thus classical authority for its basis. The terms are even interchangeable: as we read that Cæsar Augustus, on one occasion, "ordered that all the world should be *taxed*," an edict which, in its simple comprehensiveness, somewhat reminds us of the utterances of a neighbouring Cæsar nearer our own day. Another point of resemblance, I may casually observe, between that incident and the notion I have found very generally held amongst natives of India, especially landholders, is, that Augustus's census was one of the population *de jure*, that is, domiciled at or belonging to a place, not the population *de facto*, found residing in a place at the time of enumeration. Joseph, that is, had to go to be enumerated in Bethlehem. Now the class I have mentioned almost always endeavour, when they have been away from home for a while, to be in their own house for the census, so that they may be counted amongst their own people. Augustus had, no doubt, a very different object in view, but with that we are not now concerned. Anyhow, this quinquennial census amongst the Romans was the origin of a word we have adopted into

our own language when we talk of a lustre, meaning five years. After the Roman proprietor had returned the value of his estate in the census paper, he went and formally washed—performed a lustration, or ceremonial ablution. Whether this was the equivalent of our modern, but, I believe, decaying tribute of conscience-money, or whether it was the only time the Roman washed in state, I do not know, but it was a process sufficiently solemn to require a special name.

Granted, then, that whilst a census every five years is advisable for England, France, and Germany, one every decade is enough for India. The next question that arises is, whether the enumeration should be synchronous all over the country; that is, taken on a single night, as in the United Kingdom and most European states, or spread over several days, or even weeks, as in the United States of America. Where the count is of heads only, or where a simple schedule only has to be returned, and the main object is to get these requirements correctly, especially the former, there seems to be no doubt that the census should be taken throughout the country at one and the same time. By so doing, a photograph, as it were, is obtained of the population as it existed at the time fixed, and every one is counted where he happened to be, irrespective of nationality or domicile. On the other hand, where the census comprises an inquiry into industries, mines, property, and so on, as in the United States, it is out of the question to combine it with a synchronous count of the population, and this is the more to be regretted in the above States, as there is not any general or uniform system of registration of births and deaths there, so that, as in India, it is only every ten years or so, that the movement of the population is recorded. Against the synchronous system, however, there is this strong argument to be urged, that however simple the inquiry, and however extended may be the literacy of the population, the process entails the employment of a large staff of enumerators to distribute, help in filling up and to collect the schedules, but the superior accuracy of the results repays the cost. In India, a synchronous census was prescribed, and with the exception of a few tracts, the operations were conducted on that plan. The exceptions were, first, hill-country covered with forest and infested by wild beasts, where enumerators would not go by night; secondly, thinly populated desert tracts, where the enumerators could not go; thirdly, the trans-Himalayan portions of the Punjab and Kashmir, from which the enumerators could not get out till the passes opened in July; and lastly, tracts which might have been enumerated by night had there been enough men at hand competent to undertake the rôle of enumerator. The entire population, however, of all three exempted classes was small compared to the whole tale, and as it is naturally of a stay-at-home order, it was unlikely to be omitted or to get confused with the rest, in the way of double-counts.

The task of preparing the ground for a synchronous census is one, I may say, that must be tried before its extent and troubles can be thoroughly understood. There are not only general outlines to be traced, and instructions framed to fill in the details; but once these are issued, there follows the far more difficult, lengthy, and anxious task of seeing that they are understood and correctly applied. Whatever the experience of the man who drafts the rules, and the care he takes in getting them of the widest scope practicable, they are hardly in the hands of the people who are to work by them, than the rain of anomalies and "hard cases" begins to pour down. The worst of it is, that in the majority of such references, the difficulty is a real one, and has to be faced without question of precedent, since it probably was never thought of till it crops up in the course of the preparations, often, doubtless, comparatively close on to the actual census. I am not now speaking of India only, but of other countries as well, since the rules and reports I have seen from various census officers show that, in a more or less aggravated form, the difficulty of organisation is universal. In India, though we have peculiar obstacles in the way of preparatory measures, I am thankful to say that we have compensating advantages. To attempt to take a general census of that country on the same lines as are laid down for the United Kingdom would entail charges that would inevitably lead to the abandonment of the undertaking altogether. I should explain, perhaps, that in the stage of the operations with which I am at present dealing, the actual number of the people to be enumerated does not, as a rule, and certainly not in India, tell upon the cost of the census to the same relative degree as it does once the census is taken. The main difficulty in arranging for the census in India is not the mass of people to be dealt with, or the large area over which it is spread, but the

variety of circumstances severally requiring special consideration. It is not, as we have probably often heard, one country, but a small continent, differing every few hundred miles in physical features, in language and religion, or, at least, in the mixture and predominance of religions, as well as in the class and temperament of the inhabitants, and in political circumstances. Of this I may have more to say later, but, for the sake of clearing the course for the present of statistics, I may mention that against the 37,740,000 people of the United Kingdom, we are now concerned with 287,000,000. I think it is Professor Seeley who has said that after a certain limit, figures cease to convey any impression, and the above quoted round numbers have certainly an astronomical flavour about them. I will quote, however, the exact figure, namely 287,232,877, because, if a certain French writer, whose name I forget, is right in his appraisement of the public judgment on statistics, the concluding seventy and seven of the above sum will carry more conviction in favour of the magnitude of the Indian census than all the other 287,232,800 put together.

It has for some years been an object with certain statists of Imperial views to have the decennial census taken throughout the British Empire on one and the same date, and no doubt where the colonies are near together or to the mother country such a measure would, apart from sentiment, have a beneficial result on the accuracy of the enumeration. But so far as India is concerned, the number of persons admittedly enumerated at each end of the voyage, and thus appearing in both the Indian and English return, is insignificant, whilst to take the census of the former country late in the spring, when the enumeration takes place in the United Kingdom, would be highly inconvenient to the extent of endangering the correctness of the results over a great, if not the greater, portion of India. There is, of course, the comparatively minor consideration of keeping the intercensal period as near ten years as possible, and in India the enumeration took place towards the middle, or end of February in both 1881 and 1891, and in many provinces, in 1872 also. The two former, however, are the only instances of a census generally synchronous throughout the country. But the main arguments in favour of taking the Indian census in February are not statistical, but local. During that month the cultivating classes are usually at home, except for the few days before and after the full moon, when they are prone to enjoy a pilgrimage to some neighbouring hill or river. In Burma the rice harvest is over, or nearly so. In the North of India the cold is still sufficient to prevent wayfarers from travelling by night on the high roads, and the months most fortunate for marriages and their accompanying festivities have not yet begun. Again, later on, the heat would make it almost impossible for that inspection of preliminaries, which I will afterward show to be necessary, to be undertaken with sufficient energy and persistency. In the forest tracts, too, it would be still more dangerous to move about than in the colder season, and throughout the greater part of India the harvesting of the later crop would be in progress, whole families would be encamped on their fields or threshing-floors, and others would move about in gangs for reaping-engagements, miles from their homes. Altogether, taking the circumstances of all the different provinces together, a date not earlier than the 15th or later than the end of February seems to be the most suitable. In 1861, the census was taken on the 17th, and, in 1891, on the 26th of that month.

The date once fixed, the preparations have to be taken in hand, and these began in the provinces on this occasion ten months before the census. In anticipation, however, of provincial action, the whole plan of the census campaign had to be drawn up, rules framed, and forms of schedules and returns devised and published. The scheme adopted was based on that of the preceding census, with such modifications as experience suggested. The operations of 1881, being the first of their kind undertaken in India, were, of course, to a great extent, tentative; and, as nine or ten of the officers who had superintended provincial operations on that occasion were still in the country—of whom I was myself one—we followed the suggestion of my predecessor, Sir William Chichele Plowden, and held a conference well before the time when the results of our deliberations were required to be put into practice. Working on a digest of the 1881 rules and procedure, which it fell to me to prepare, we threshed out a complete code for use in 1891. I need hardly say that the lapse of nine years had deadened, if not obliterated, the effects of the pinching of the 1881 shoe; but the looking over our old forms and rules brought vividly back the memory thereof, and we were thus enabled, I hope, to cobble up a better fit for our successors,

instead of inflicting on them, as we had ourselves been obliged to undergo the trouble of wearing into shape a brand-new article on the Procrustean model of the ammunition-boot, which is guaranteed to fit all customers. As soon as our proposals had received the approval of the Government of India, which was given after consultation with the authorities of each province, the real work began. A Superintendent of Census Operations was appointed for each province early in April, 1890. He was, generally speaking, an officer selected from what is called the district or revenue staff, of some years' experience of the language and customs of the people, as well as of the system of administration, from the village upwards. In one case only was it necessary to find a superintendent from the staff of a neighbouring province, and this was owing to the temporary paucity of district officers on duty. The post of superintendent of a census is one of some delicacy, requiring considerable tact as well as knowledge of the people, and above all things, physical toughness. It might be expected that I should add statistical knowledge or aptitudes, but I must confess to a preference for the administrative faculty, with, of course, due deference for accuracy in the matter of two and two. The greater part of the statistics collected at an Indian census are intended for current reference by men who only want to be certain that the figures carry their meaning on the surface, and that where they are incomplete or partial, the origin and extent of the defect is made clear, and explained along with the tables themselves. The common gibe as to the fallaciousness of figures rests entirely on the fact that the latter are nearly as often abused as used in public discussion, since there seem to be few collections of statistics of any considerable scope or extent, which can be taken neat-undiluted, that is, without copious explanations. What I may call the esoteric branches of statistics, with which, however, I do not propose to trouble you, can only be safely dealt with in the mass, collating and examining the numerous distinctions that go to form a more or less consistent whole. But this is a digression from my subject, which is the qualification of an administrator of the census work. He must have tact, as amongst other things he is usually junior to the heads of districts, whose arrangements he has to criticise and bring into harmony with the general lines laid down for the enumeration. Knowledge of the people is necessary, in order that he may frame rules and illustrations on purely local points where error is likely to occur, and avoid offence to religious or caste feelings. He must be physically sound, as the strain, especially for a month or two before the census, is remarkably hard, and even before that time, the amount of local inspection and travelling about on district consultations through the hot and rainy seasons, is no child's play. I must not conclude this portion of my subject without mentioning how much the value of the enumeration in 1891 was enhanced by the trouble personally taken by all the superintendents to show that every detail in the preparatory arrangement was in efficient working order, and by their success in enlisting the full co-operation of the district officials through whom they worked.

But I find that I have omitted to describe what the duties of the superintendent really are, and to do so is necessary, though I will make my remarks as short as possible. To summarise his work, he is bound to arrange that no one in his province shall escape enumeration on the one hand, or be enumerated more than once on the other. The unit of district administration throughout the greater part of India being the village, it is with this that the census registration began. Villages were grouped into circles, each under an inspector or supervisor. In Bengal, and parts of Assam, however, where the village-system has been dissolved in favour of estates, the superintendent has to begin a stage further back than elsewhere, and obtain a list of what are considered villages in each police or revenue subdivision. Next comes the demarcation of the village, or group of villages, into areas to be placed under an enumerator, technically called blocks. In towns the corresponding registration took place by wards, or other subdivisions, but the system was everywhere uniformly adopted. The houses in each block were then serially numbered and registered, under strict supervision, and the resulting register, when finally passed, was the basis of enumeration. From the above description it will be seen, that except perhaps in a few parts of the country, there is less chance in India than in England that any considerable collection of residences will escape enumeration. In England the artificial boundaries are not only numerous but bear no relation to each other, whereas in India the subdivision can always, with the exceptions I have just mentioned, be reduced to its lowest term—the village. Allowing, then, the greater convenience, for census purposes, of the village in

India over the parish in England, I must admit that, so far as statistics of houses go, the former is far inferior. In England the definition adopted for a house is universally applicable, and, if supplemented by that of a tenement, all necessary statistics can be readily obtained at the census. But in India, the variety of dwelling and in the domestic habits of the people is so great, that no one definition can be framed that will apply throughout the country. It is very doubtful if even in a single province the local definition is uniformly applicable; so that in the towns of Calcutta, Bombay, Rangoon, and probably Madras, alone, are the statistics regarding house-room really valuable. For all practical purposes connected with the enumeration it was enough that every building should have a number affixed to it, so that it could not be passed over; but under such a system the wattle and daub-hovel, a few feet square, and the castle-like enclosure of the village magnate, containing over 100 people, appeared in the register as in the same category. As I said above, this was inevitable, and though provincial, or at least divisional, uniformity may have been in many cases secured, it is labour wasted to make use of the return of houses in a review of the whole country.

Returning to the preparatory measures, I have to add that in supplement to the arrangements for towns and villages, the provincial census officer had to see that travellers by road, river, and rail, were duly enumerated, and to provide a staff for taking the census of vessels, not only those actually in harbour on the census night, but coasters arriving afterwards without having been caught at any other place of call. For all such cases general rules were issued from the central office, and local modifications made as each case demanded. The rules, I may remark, about railway travellers, give considerable trouble in India on account of the length of the journeys, and though on the whole they worked efficiently, I have become aware of instances even within the circle of my own acquaintance, in which, from excess of zeal the same person was presented with from three to four schedules at different parts of the line. The general practice was to enumerate passengers as they alighted during census night, and to turn out the whole lot remaining at six o'clock the next morning, and enumerate them before letting the train proceed. I heard no complaints about the delay. In England it would have been otherwise!

Concurrently with these arrangements for registration and so on, the superintendent had to look after the preparation and issue of schedules: and here again we have a point in which India is at a great disadvantage compared with England. The form of schedule and the code of instructions for filling it up were uniform all over the country, barring the examples and illustrations, which had to be made up to suit the locality. But then arose the difficulty of translation of both rules and headings, for in India the census is taken in at least seventeen languages, several of which require forms in more than one character. In England, a few schedules in Welsh were all that were not printed in a single language. The diction, moreover, into which the forms were rendered must be that of the vulgar, because the style of translation which commends itself to the official scholar is as often as not unintelligible to one not acquainted with the language of the original. To meet this difficulty the provincial superintendent took into counsel that universal referee the "experienced district officer," and I believe got, as usual, what was wanted out of him. Then again, the examination of the indents for forms and the despatch to each district was an immense undertaking, since very often, if not usually, a great many more were, through caution, asked for than were actually wanted. As it is, a rough calculation indicates that between eighty and ninety millions were issued. Taking only those that were probably used, we find that they weighed about 290 tons, and would cover, if spread out, an area of 1,300 acres, and if put end to end, again, would stretch over 15,000 miles, or more than from India to England and back. All this mass, except the few demands which, as always happens on such occasions, come in by despairing telegrams close to the census time, had to be printed, despatched and distributed to local centres by the end of December. It was dealt with by the Government presses, except in a few instances, where lithography had to be used, and I must add, with the greatest possible economy, punctuality, and efficiency in every respect.

This narrative, which I fear is becoming tedious in its detail, has now reached the point when the enumeration itself is in question. Here we diverge altogether from the English system. In England, as you know, the schedule is left with each householder a few days before the census, and an enumerator recovers it, fully filled in, the day after. If

the householder is unable to fill it up himself, he is instructed to invoke the aid of some competent neighbour, but the whole onus of the return falls on him, and the enumerator is practically responsible for only distributing and collecting in full tale the schedules for his beat. In India, on the other hand, this system can be made applicable to none but the comparatively small European element in the population, and to native gentlemen, high in rank or official position. In the city of Bombay alone has it been in force throughout the community for the last three enumerations. The mixture of races and languages in that town is, no doubt, a strong argument in its favour, and the error in detail in 1891 was less than I should have expected from my experience ten and nineteen years before, on both of which occasions I happened to be in Bombay on the census night. The standard of education, however, is, of course, a good deal higher there than in the rural tracts and smaller towns. In the United Kingdom, I suppose, not more than five or six householders in a hundred are now unable to fill in their schedule, but in India the proportion must be reversed. In fact, I doubt, if taking the number who can read and write, and discounting those of them who are not capable of comprehending the rules for filling the return, you will find two in a hundred who could be trusted with this duty, and the literate amongst their neighbours would not *ex hypothesi* be numerous enough to undertake to do it for them. There are whole tracts of country in different parts of India, both British and feudatory, where there is not a single person within miles who can even sign his name, except the village accountant and the local money-lender. In such cases it is necessary, of course, for the State to undertake the whole responsibility of the census, and the burden is thrown accordingly on the accountant, to whom the money-lender, in the circumstances, affords most useful and gratuitous aid. But it is the same, to a greater or less extent, all over India. A schedule left for three days in the house of nine out of ten of the population would be mislaid in a hole in the tiles or thatching, or strangely plaited and tied up, like a court summons, in a corner of the householder's waistcloth, or again stuck, like a turnpike ticket, into the folds of his turban, and forgotten. The tenth man would probably spend some happy minutes, not inaudibly, in discussing its legality with the enumerator, or return it endorsed casually with the primitive addition sums necessary to the balancing of his day-book. This might not be the case in Burma, but I do not think that even there the returns would be properly made. The general result is that the schedules are not left in the charge of householders at all. The duly appointed enumerator of the block has them all bound into books of convenient size, with the rules in the beginning and the numbered-list of houses at the end, and a printed sample or two of schedules filled up in illustration of the more knotty points raised in the instructions. By the way, with reference to these illustrations, an amusing incident was told me by one of the provincial superintendents. He had found during his inspection the same class of misconceptions uniformly running through so many districts that he embodied them all in a printed schedule, which was circulated, with a note, explaining each error. Shortly afterwards he received an urgent appeal from one of the officials engaged in arranging for the district census, imploring the superintendent to withhold the said illustrative schedule from publication, as it contained several serious mistakes, correction of which accompanied the communication! I remember a similar case years ago, in which the head master of a high school prepared an essay containing, in italics, all the errors in English most common amongst his pupils. This was taken for some time as a model of composition, and followed with fidelity. Moral: illustrations and samples are not always instructive.

To return to our enumerator. It is obvious that if he has to fill in an elaborate schedule for each household, the latter numbering from three to fifty persons, he can only get over about a dozen, at most, in a night, even without reckoning the time wasted in extracting the information required, and in getting down in the return all the babies, unmarried girls, and old women, who would be left unmentioned if the householder had his way. So that, at this rate, the night census of our 287,000,000, more or less, would require over 4,500,000 of enumerators. Now, the total number of persons of fifteen years and upwards who can read and write at all in the 262,000,000 odd, from whom the information was demanded, is about 11,340,000, and allowing about the same proportion in the rest of the country, which is more than is due, we have an adult literate congregation of 12,500,000, on which the demand for enume-

rators would have fallen to the extent of about one in three.

To avoid this difficulty, in the first place, the average size of a block in rural tracts and small towns was fixed at 60 houses, or about 300 persons. We thus required not more than 950,000 enumerators, instead of 4,500,000. Secondly—and this I must impress upon you is the cardinal point in the whole census-taking—the enumerator, at a certain varying interval before the census, went round his block, and filled up all his schedules for the ordinary residents of each house, and for such sojourners as were not likely to leave before the census night. He was not bound to enter a lot of guests and visitors simply stopping a few days for a marriage or pilgrimage, or come shopping from neighbouring villages, as all these, under the rules, would be registered by the enumerator of their own block as if they were present, since their family or neighbours would tell him that they would be back for the census. Thus, not only was nearly the whole census—in fact, the whole of that of the ordinary population of a place—taken in anticipation of the synchronous operation, but the interval afforded time for a most expensive and thorough inspection of the enumerators' work by both district and census officers. In this way, the rules were illustrated in their actual working, and the results were, on the whole, most conducive to accuracy of detail. Personally, I had the opportunity of seeing this part of the enumeration in many towns of the North-West Provinces, Oudh, the Punjab, Sindh, the Central Provinces, and Bombay, from the Khaibar to the sea, and it gave me an excellent notion of the quality of the work and the direction which statistical errors were most likely to take. After this inspection by the local census officers, all the enumerator had to do was to go over his register again on the census night at each house, and bring the return up to date by striking out the entries of the inmates who had died or departed since he was there before, and entering those who had been born since or who had come to the house as visitors. These alterations were made in red ink, so that they could be easily checked, and a good supervisor could tell very soon thereby whether the enumerator had really visited his block thoroughly or not. My impression is that in towns the final check was invariably done in accordance with the rules; in ordinary villages, too, this was generally the case, whilst in scattered villages probably the round of the houses was made on the afternoon preceding the census night and the early morning following it, and the evening was reserved for entrapping travellers and vagrants, or in discussing the schedules with the local elders in the village meeting-place. Now from the description I have given of our plan of procedure, it will be seen that there is practically a double enumeration, one original, the second a test of it, so that the chances of accuracy are very good, as Sir Richard Temple pointed out in a recent article he published in the *Fortnightly Review*. The system adopted has also all the advantages of the non-synchronous enumeration, and still keeps intact the main object of simultaneous registration, namely the prevention of omission or double-counting. It seems, on the whole, the best, even if not the only system that could be carried out in India, but it is clearly unsuited for countries where clerical labour is expensive, or the body of state officials comparatively small. One of the great advantages India possesses in connection with operations of this nature is the village system. I have already mentioned how it helps in mapping out the country into areas for census enumeration and supervision; I have now to add that it provides the bulk of the agency available for that purpose. In provinces and states where this system is in force, all statistics of births and deaths, vaccination, diseases, crops, cultivation, revenue, boundaries, and I dare say other matters are traceable to their source in the village accountant. In Bengal and the neighbouring districts of Assam, I believe, the local constable or watchman is the purveyor of information on most of these subjects, and the census had to look elsewhere for its staff. West and south of Bengal, however, the accountant who enlisted the services of his family, some of whom were usually in training for the post; the village schoolmaster, when there was one, and some of his elder pupils; the local grocer and his writer; and, in towns, the municipal commissioners, their relatives, clerks, and the corporation establishment, constituted the bulk of the census officers, with the addition of every Government clerk who could be spared for a couple of days before and after the census night. In most provinces, too, very efficient aid was gratuitously given by all non-official classes, especially in supervising the carrying out of the published rules, so that comparatively little expense was incurred on account of agency. It was made a rule, too, that every one should

be given a beat as near as possible to his own residence, so that he could give his services more conveniently to himself, and without interfering with his other avocations. There were cases, of course, in which specially engaged enumerators had to be despatched long distances into wild and unhealthy tracts. These men were well paid, but their number was kept down as much as possible, both to reduce expenses and to get the work done better, since it was found that greater accuracy was to be got out of the regular staff, working non-synchronously, than by employing for a few days a lot of irresponsible hands, who dreaded the jungles and despised the inhabitants thereof, and whose main object was to get back home as soon as they could, and touch their reward. The instruction and drilling of this army of enumerators was a matter that required much attention and time, especially as the superior census officers had first to be put through the same mill, in order that they might appreciate the difficulties of the task, and understand the details of the rules. The usual plan was for one of the district staff to take a class of the supervisors round a few houses, and enumerate the inhabitants, either before or through his pupils. Or, again, witnesses or applicants present in a court or at a magistrate's camp were pressed into services as subjects. The servants, clerks, and messengers of some of the superintendents were so often put through the process, by way of illustration, that they got to be quite experts in the schedule, and no doubt made excellent enumerators when the time came.

We have now traced, vicariously, the path of census administration up to the point at which the returns have been obtained. Here we cease our dealings with the public, and the technical part of the work begins, in which the new material is worked into statistical form. Before I enter upon the scope of the inquiry, I had better finish with the enumerators, for their job was not quite over when they had completed their round on the census night. First, they had to repair to the head-quarter village of their circle or ward, as the case might be, and there have their books of schedules examined and passed by their superiors. There were generally about ten blocks in a circle, and as soon as a book was examined, it was returned to the enumerator, who totalled the population by sex, and then the occupied houses, and passed the results to the supervisor on a slip of paper. The book was then made over to a second enumerator, who did the same addition. If the two results tallied, the totals were entered in the form kept for the circle, as well as on a slip attached to the book. The circle was then totalled, and the result brought to the sub-divisional head-quarters, from which it was sent in a second edition of the slip to the district centre, and the district population, when compiled therefrom, was telegraphed to me in Simla, confirmed in a detailed slip, sent by post. A duplicate was also sent to the Provincial Census Officer.

The number of districts in India and Burma is, or rather was in February, 1892 (for some changes have been made since), about 250, and of states and agencies communicating direct about 100. Added to these were 60 or 70 large towns, and all the correcting and revising messages. Telegrams began to arrive on the second day after the census, and for the next fortnight they pattered in at the rate of from five to 40 a day. The exuberant zeal of some officials led them to class their communications as "urgent," which, according to Indian rule, compels the telegraph office to deliver them at once by special messsenger. I had visions of this beforehand, and had warned the office that the Census Commissioner was worthy of his repose, and that nothing was urgent after his office was closed for the day. I fear, however, that my assistant, who had not thought of this precaution, must have passed several disturbed nights, as the telegraph officials doubtless felt bound by rule to deliver urgent messages somewhere or other, and, therefore, shot them out on him.

I now pass on to an entirely different topic, namely, the information required at the census. There are certain subjects which, it has been argued at various international statistical conferences, should be invariably included in a schedule, and of these the most important are age and sex, which enter, also, into most of the other branches of census statistics. In India, especially, where the results of famine often seriously disturb the balance of both in their normal distribution, the comparison between two enumerations is both valuable and interesting, since even though the ages may be anything but correctly returned, the misstatements are probably on the same lines on both occasions. Again, in most countries a return is made of the single, married, and widowed. In one country I know of, the census goes further, and tabulates the divorced, and also those separated from bed and board; but we were

content with the three normal conditions in India, and even divorce, which had to be provided for in the rules, was not found susceptible of uniform treatment. In one province it was returned under widowed, which is correct according to the instructions, in another it was either not mentioned at all, or the divorced were returned as married. Yet it is a recognised condition and of no rare occurrence. These returns of civil condition in India are of some importance owing to the widely different marriage systems which are found in that country, and to the possible effect of some of them on the physical and moral character of the people who follow them. They have been somewhat prominently brought into question during the last two or three years, owing to legislative action, past and present, and the result of the census will no doubt, in respect to the returns on this subject, be widely and carefully scrutinised, but they do not fall within the scope of my present paper.

A return of birthplace may be included amongst those classed as necessary at every census. Apart from any question of a nationality or allegiance, the recruitment of the population from outside, and migration within the country, are both important subjects, particularly in India, which presents the extremes of both density and paucity of population. It receives, too, on the east the pressure of a foreign population notorious for its immigrating instinct, and on the opposite frontier is colonised by a race whose sympathies are not always with those who would rule over them. It was, therefore, decided to obtain a return of birthplace by districts for each province and its contiguous neighbours, and by provinces for the rest of the country. This gives the means of judging of the immigration from one district into another, and as the return is by sex, it will show whether the movement is real or merely the usual interchange by marriage according to the Hindu custom of seeking a wife from another village more or less distant. It is also useful to see the extent to which the districts of the province contribute towards the population of the large seaport cities, since the latter are notoriously largely maintained from outside. A subsidiary matter in connection with such a return is that from it can be seen, so far as the province and its neighbours are concerned, which districts or states are the chief exporters of their males, and which, on the contrary, provide resources for all their indigenous sons within their limits. In time, with a population so varied in race, language, and religion, and a country differing so widely in different parts in fertility and resources, a return of this description yields a complete harvest of valuable information, provided sufficient time be given to its exploration.

The question of returning parent tongue at the census was finally decided in favour of retention of the column in the schedule, though it was not suggested that the object with which it was originally introduced, namely, that its connection with birthplace might help in deciding nationality, should be kept in view. It is to be tabulated, accordingly, from a philological standpoint, simply as indicative of the relative strength and the various synonyms of the numerous languages and dialects found in India. There are possibly a few instances of overlapping languages in which it may be useful to ascertain how far one has been getting predominance over the other during the decade, but the chances are that a question of this sort will have been settled between the district and the educational authorities without any need of census information.

The question of nationality, which I have just mentioned, was settled by using that term in schedules issued to European foreigners, in whose case alone is the information ever required. In the vernacular editions, the column was headed sub-caste or class, and in the triglott schedules used in Bombay city, this led to some curious confusion between the terms amongst the English-knowing non-European population. In the same way, the word race was used in the English form, and caste or tribe in the vernacular; and, I may say, the returns under these two columns together added a very considerable amount to the labour and expense of dealing with the results of the census, as the confusion between the two was almost inextricable without referring right back to the original schedule to see what the individual really meant. The whole question of caste and tribe in India is such a wide one, that it will be out of the question for me to enter upon it in this place. For the information of those of you who are acquainted with the caste system, I may state that in addition to the return of the strength of each caste, the series of caste-tables includes one showing the four selected infirmities, of which I have still to speak, by caste; also those who know how to read and write by caste, distinguishing those who know English from the rest; and, finally, though not for the whole of India, a statement show-

ing marriage statistics for each caste by different age periods, indicating those where infant marriage and widow re-marriage, &c., are respectively prevalent, and the different provincial or territorial custom in those respects. I need not tell those whom I am now specially addressing that this series is a very bulky one, though, I must add, that save within broad limits, it is not likely that the information can be welded into an imperial total of much value, but must be made use of by uniform groups or in its provincial form.

The return of infirmities which I spoke of in connection with caste, comprises two tables, one showing the infirmity by age for each sex, the second that by caste, just mentioned. The four infirmities selected for inquiry are unsoundness of mind, that is both lunacy and imbecility, congenital deaf-muteness, blindness, and leprosy. I fear the returns are far from complete, but in this our census does not much differ from that of other countries. For instance, it is difficult to get the deaf and dumb separated into congenital and others. Blindness I fear, too often includes the one-eyed, in spite of there being a special and different name for the latter. Leprosy is a term which has unfortunately been associated in the case of an Oriental, with whiteness of skin, from Gehazi downwards, so that possibly, though every means were taken to prevent it, leukodermacy has, though in comparatively few cases perhaps, passed into the return with the true disease. Moreover, as to leprosy, either women are not effected to anything like the same extent as men in India, or there has been serious concealment of the disease amongst the former sex, for the disproportion between the two is astonishing. This, however, is another question concerning the results of the census, which like the former, must be set on one side for the present.

A further subject on which information is collected in India in accordance with the custom in a few Occidental countries, is that of education, or rather degree of instruction. We used three heads, those who are under instruction, those who are not, but can read and write, and those who are not, and cannot. These are returned under three age-periods, though unfortunately the latter, which are based on fives, do not commend themselves to the educational authorities, who have selected multiples of six for their statistics. Considering the general quality of Indian age-returns, I do not think the difference is material. Probably the chances are equal that a person returned as 5 is 6 or 4; 12 again, is far too favourite an age in our return, at the expense of 11 to 14, and 18 is possibly used as the equivalent of anything between 16 and 19. I I think, too that we of the census conference were injudicious in recognising those under instruction at all, and that a more useful return would have resulted had the distinction been simply between those who can read and write and those who cannot. I have mentioned above that this general return is supplemented by caste details, so far as those are concerned who can read and write. This is with a view of ascertaining how far down the social scale, which is fairly enough measured by caste, has this degree of instruction penetrated; and also, in the same way, amongst what castes is the knowledge of English found, and in what proportion to the total number who can read and write.

There remain two subjects, occupation and religion. As to the first, statistical opinion is divided regarding the value of a census return. Experience in some countries has shown that the subject can only be properly treated by a special inquiry, more minute than can be obtained at a census. Others hold that, by dint of instructions and supplementary columns, a valuable amount of information can be got on to the schedule. I am inclined to range myself in the former camp, as I fear the best census return will always contain misleading figures, and that, too, with reference to perhaps some of the most important occupations. The return in 1881 was considered by most of us who had the handling of it so inadequate as to the number of persons engaged in the different occupations that we recommended that the distinction between worker and dependent should be dropped, save as a salve to certain prejudices which would object to the ascription to a woman of a distinctively male occupation, and *vice versâ*. Our suggestion was accepted by the Government of India, and the occupation return contains against each entry the males, females, and both combined, for town and country severally, under suitable age-periods. Thus the grand total of these facts shows the number of persons living by a certain occupation, whether they work at it themselves or are supported without working by some one else who works at it. The results remain to be analysed, till the completion of which process my judgment remains in suspense on the value of the return.

As regards religions, which are not recorded

at the census of England, the Indian return is of interest in several ways, and of practical value in some. The Mussulman, Zoroastrian, Jew, Christian, and Buddhist, are all well defined, and comparison with former enumerations is possible and probably accurate. But when we come to Sikhs, Jains, and Hindus, and get down to the religions of forest tribes, which last have been tabulated under the collective title of animistic, we enter territories the boundaries of which are as undefined as those of the Pamir or Upper Burma. The outskirts of Hinduism, especially, are as uncertain as the course of exchange. There is no doubt that Brahmists, and the newly-found title of Aryan may for all practical purposes be considered as still within the fold. Jains, too, have been known to return their religion as Hindu, but of the Jain sect. Sikhs are better defined, but the distinction, except perhaps amongst the fighting classes, is a good deal one of ritual. As for the Forest tribes, except in and near Burma, it is often impossible to state where Hinduism ends and the fetich, or tribal form of worship, begins. The former, in fact, only seems to acquire cohesion when placed in antithesis to Islam, and in parts of the Punjab the lower classes do not seem to be dogmatically sound even in this respect. The relative strength in the towns of the north, of Hindu, Mussulman, and Sikh, is a detail often requiring attention. In fact, in almost every large town in India the tabulation of the two former may be of use. The antagonism of the two creeds is always in existence amongst some classes of the community, and a very small local circumstance may turn out to be the very match required to kindle it.

I think I have now traversed the whole field of the census inquiry, and have sufficiently shown what it was that we set before ourselves to do, and how we arranged to do it. All that I have left untouched are the expenses, and the purely technical processes through which the returns pass from the individual entry in the schedule to the aggregate of the provincial or Imperial total. These last are highly complicated, and I will ask you to take my word for it that they are exceedingly uninteresting, especially to one who has just been engaged in winding them up. They are also the most expensive section of the operations, and this is the less satisfactory, because most of the cost is incurred for the sake of insuring by revision the accuracy in tabulation which one inexperienced in such matters might reasonably presume would be attained in the original work. They also cause perhaps more anxiety even than the enumeration, because the operations are more concentrated, and the means of check and correction are always available, and sometimes misused by a trusted subordinate. Last, but not least, they afford the fullest opportunity to the Census Commissioner, awaiting the provincial returns in the Olympian atmosphere of Simla, to become disagreeably importunate.

We have come now to the climax of all public entertainments, the bill. It will not need the classic quarter hour of Rabelais to consider, for I hope I have succeeded in showing that what may, at least for the present, be considered an equivalent, has been prepared. Whether digestion will confirm my opinion is a matter of time, for, like Martial, my aim is that the fare should please the guests not the cooks, and the provincial dishes have still to be ordered into an imperial banquet. The total sum falling on the taxpayer in British territory, excluding, that is, the States, but including the whole cost of my own personal share in the operation, is about 25 lakhs of rupees, calculated up to the end of the whole business. But out of this a considerable sum, of say Rs. 50,000, was incurred on account of the smaller and less advanced of those states, so that, in order to arrive at the more or less correct incidence of the charges per head, it is necessary to omit that amount, and restrict the calculation to the provinces alone. By this means you will find that the rate per 1,000 people was as nearly as possible 10½ rupees, that is 14s. 8d., taking the rupee at 1s. 4¾d., which is a fair average for the time when the money was being spent, though, unfortunately for us of the salaried classes, it is so no longer. Ten years ago, the corresponding population dealt with was 195,500,000 as against 217,500,000, and the cost 24½ rupees, so that with a task increased by over 11 per cent., not to mention the very material increase in the amount of information tabulated, the charges remained practically the same. This result is greatly due to the experience gained at the census, with which I have just been comparing that for which I am responsible, and to the warnings of my predecessors, of which due advantage was taken. It is not fair to institute a comparison between the above rates, and that in England, which, in 1881, was £4 18s. 4d., because against the greater mass and complexity of the population with which we have to deal in India must

be set the great advantages we derive from our village staff, and from the fact that the supply of clerical labour, of a sufficiently good quality to be of service in census operations, is, at all events in most of the larger provinces, in excess of the demand. For instance, when the abstracting offices were in full work, we had about 15,000 clerks employed, and by judiciously seconding for a time permanent officials of a certain rank, adequate inspection and supervision were ensured.

I will now conclude this account of the Indian census and its administration with a few remarks of a personal nature. The vital point of census statistics above all others is uniformity, that is, the figures must everywhere represent identical facts, in varying degrees. It is essential, accordingly, that the direction of the operations should be centralised; but it is none the less necessary that the application of the rules thus issued should be identical throughout the country. Now, the circumstances of India are such that it is out of the power of any one man to grasp them all in the detail required for a census, so that much of the responsibility of ensuring uniformity of results was imposed upon the provincial superintendent. For every general rule or instruction issued, and for every form prescribed, the sole responsibility rests on me, but once in the hands of the provincial officer such matters had to be moulded in the local groove best tending towards the desired results, and my position was by no means that of wire-puller, but rather of chief of the staff. Many a thousand miles did I travel, and many if not most of the important cities of India were visited by me in my tours of inspection, and though the experience thus gained must be but superficial, I saw enough to satisfy me that the figures we have collected are based on facts as much in one part of the country as in another, and that on the whole the connection is a very close one. The reviews of their provincial figures by my colleagues, which are now either published or to be issued shortly, prove the interest and value of the results. There is also this to be considered, that such works, each containing, moreover, from 250 to 400 printed pages of closely tested tabular matter, were prepared in from 13 to 15 months of the census, whilst within a month from that date substantially correct figures for over 286,000,000 of people were made available to the public. These results could only be obtained by months of incessant and anxious toil, and the exercise of the best administrative faculties; and all this is evidence abundant that the labourers in both provinces and states were altogether worthy of the magnitude of their task.

DISCUSSION.

Sir WILLIAM PLOWDEN, K.C.S.I., M.P., said he had listened with interest to this account of the difficulties which Mr. Baines had to encounter, and of the successful way in which he had overcome them. The first point which must strike the attention even of those not acquainted with India, was the enormous area and consequent amount of work which had to be done; as shown for instance by the figure of 250 tons of paper used in the schedules. As a former Census Commissioner, he was quite able to realise the truth of this statement, because in the former enumeration in Bengal, Mr. Bourdillon informed him that his papers, not the schedules, but the abstracts which he sent in, would have filled an ordinary luggage-train. The next striking point was the extraordinary success of the operation. To think that in two months after taking the census the public were informed of the total figures enumerated was very remarkable. In the 1881 census, his predecessor, Sir Charles Elliott, and himself, with all their efforts, were unable to get out the figures until late in 1882. He might point out that this was only the second imperial census which had been taken, although the people were thoroughly accustomed to enumerations of this nature. Madras had the most ancient history in that respect, at all events since the British occupation, the enumerations going back for fifty years; but in the North-West Provinces the first census was taken in 1847, and since 1851 it had been repeated at decennial periods. Mr. Baines had remarked on the great facilities given by the village system, and shown how through the village accountant or watchman an immense amount of information was collected continually, and at the beginning of a census a great deal of work was done by these officers for which they were paid little or nothing, though but for their aid the counting of such an enormous population would be utterly impossible, with the details which were included. He had noted the particulars specified by Mr. Baines, some of which were not included in the English returns, viz., age, sex, civil condition, language, race, or nationality, caste, four specified infirmities, condition of education, and religion. One of the principal matters which called for attention was the great difference in the manner in which the information was collected as compared with the practice in England. Here it was essential to success that the schedules should be compiled by the people themselves, the per-centage of those who did not do so being almost infinitely small, but in India it was exactly the reverse; the whole of the enumeration, with the exception of perhaps from 5 to 10 per cent.,

being effected by the enumerators, who first went round and collected the information, and then on the census day finally corrected the schedules. The reason for this was obvious, and appeared on the face of the return which Mr. Baines had already sent in to the India-office, a rough copy of one of which Sir Charles Bernard had kindly given him. The state of education accounted for the whole matter; for it appeared that only about 4 per cent. of those above the age of 15 were able to read and write. Such a state of things would be incredible in England or any western country, but he was glad to say that this per-centage was twice as good as it was ten years ago, showing what rapid strides education was making. The cost of the census was very satisfactory, being only £250,000, or, rather, at the present rate of exchange, about £180,000, which was not a large sum for collecting so much detailed information with regard to a population of 280,000,000. In England the cost was much greater, mainly in consequence of the difference in the value of money. If 125 lakhs were multiplied by six, it would be about a fair comparison, and it would bring the cost to £1,500,000, taking the rupee at 2s., or at the present rate of exchange about £1,100,000. He was glad to see how successful Mr. Baines had been in making use of the experience of the past. In 1881, an enormous amount of difficulty was experienced in various provinces through the officers appointed to superintend the census not having been brought together early enough to make the preliminary arrangements. When Lord Cross consulted him on the appointment of a successor to conduct the 1891 census, feeling how necessary it was that preliminary arrangements should be made in which previous experience should be utilised in order to secure uniformity and accuracy in the returns, he mentioned the names of two of the most efficient provincial enumerators, first, that of Mr. Baines, secondly, that of Mr. Ibbetson, who wrote one of the best reports in 1881, and was now exercising high office in the Punjab. But Mr. Baines was exceedingly successful as the enumerator in Bombay. His report was remarkable for its easy flow of language, its extreme acuteness of observation, and for the grasp it showed of the fact and figures dealt with. The work he had now done showed how fully justified Lord Cross was in conferring the appointment upon him. He only regretted that the present paper did not contain some information as to the results of the census, the most prominent one being the enormous growth of the population, especially in Madras. There had been of late some extraordinary utterances in the House of Commons with regard to the present condition of the population of the province, the exceeding scarcity, and possibly impending famine. There could be no doubt that while in previous years there had been, especially in the neighbourhood of Mysore and parts of Madras, an enormous decrease of population, occasioned partly by famine, but more so by disease following on scarcity, the population of Madras as evidenced by the late census had increased to a much larger extent than that of any other portion of imperial India. That was fair evidence that the statements, hazarded without much knowledge as to the condition of the people, were either entirely unfounded or very much exaggerated. According to the returns he had seen, there was only one part of India where there was the slightest falling off in population, viz., Coorg. He could not understand how it occurred, but the figures were only about 140,000, which showed a slight decrease as compared with 1881. In every other case there had been a steady growth. He believed himself that in all parts of India a healthy progress was going on. A great deal, not worthy of credence, was said as to the poverty-stricken condition of the people of India. He had had a long experience as a district officer, and he must say, going back to the time when he first entered the service in 1852, and the district with which he was most familiar in 1854, to which he afterwards went again as collector, and once again as Commissioner, viz., Meerut, he could see a most marked improvement in the condition of the people in the thirty years which had elapsed. Of course there was poverty there, as there was everywhere, but the people were improving in condition, not only physically, but also morally and socially; and the Government had done much to foster the development of the country. He believed they might fairly look forward to further and further progress.

Surgeon-Major J. M. Cuningham said he was interested rather in the results of the census than in the means by which those results were obtained. He came in the expectation of hearing some of these results, and ventured to hope that next Session they might have a paper from Mr. Baines giving some details of the most important points of the census.

Mr. M. M. Bhownaggree also agreed with the previous speakers that Mr. Baines had given an excellent description of the way in which the census was taken, but thought the paper would have been more interesting if some of the results of the census had been given. He hoped they would be favoured with the same in the course of the next Session; meanwhile he would refer to one important point which had also been mentioned by Sir William Plowden, and that was the state of education in India generally. He thought if some of the funds which were now devoted to what was called higher education were distributed more fairly, and expended on elementary education, there would be a larger per-centage of educated people returned in the census papers. He hoped that would be the case before the next census was taken, ten years hence. It was a matter which did not really fall within the scope of the paper, and therefore he would not dwell at length on it, but at the same time there was a great lesson to be drawn from the results shown by the census on this head; that, while a few selected portions of India could boast of being

educated in the classical literature of both hemispheres, it was deplorable that such vast masses should be returned as entirely uneducated. The future regeneration of India, in great measure, depended not on the high quality of education so much as on the area over which it was spread. He hoped this matter would not be lost sight of by those who guided the destinies of the Indian Empire.

Mr. W. MARTIN WOOD said he had been much interested in the paper, and was glad to find that Mr. Baines had been so successful. The rapid increase of population in Madras, which Sir William Plowden had referred to, must probably be referred to an effort of nature to restore the balance so rudely disturbed by famine, as shown by the census of 1881. He was glad to hear his remarks criticising the statements made as to the general poverty of India. He did not quite follow them; but trusted they would be taken notice of, and that the question should be gone into more thoroughly. With regard to Mr. Bhownaggree's remarks on the small number of literates as compared with the advance in higher education, he thought it was not necessary to put the two branches of education in antagonism to one another. That very small per-centage included the collegians, as well as those who had only the three R's; and it was very undesirable to say anything to further the disposition already shown by the Government and the India Office to restrict the funds devoted to Collegiate education. While so doing, they did not give the funds to the advancement of primary education, but threw the expense of that more and more on the communities themselves. If it were a question of finding funds for primary education, there was an expenditure out of all proportion to these paltry items, which was now being squandered beyond the frontiers of India, thereby straining the resources of the country in every direction; and increasing the anxiety that everyone now feels as to the immediate future.

The CHAIRMAN said they were all much indebted to Mr. Baines for this paper. Something had been said about the paper not giving any of the results of the census, but the fact was, the figures were not yet fully compiled; and it was their compilation and correction which had detained Mr. Baines in India, and so prevented his being present. He hoped, however, in the course of about six weeks, to be in England, and to read a paper before the Statistical Society, and that, before the end of the year, the full census report would be published. Something had been said in the discussion as to the magnitude of the work, and there was no doubt that the taking of a census of 286,000,000 of people and the publication of the results within a few weeks was the biggest thing of the kind ever done. He was very glad that Mr. Baines had brought out the fact that India was a continent of many countries, nations, races, and religions, and it was this diversity of language which made the taking of a census in India so difficult. Something was said about the good work done by the enumerators, and he did think the Government and the people were immensely indebted to them. It was not as if they were employed for one night only, but for weeks and weeks before the counting; and the supervisors, most of whom also were voluntary, and who had previously instructed them, corrected their work. There were about one million of these enumerators, most of them voluntary workers; in Bengal alone 400,000 were employed, of whom less than 200 were paid. It was most creditable to the public spirit of the Indians that they should in this way have undertaken the work, as volunteer officials. It was because all the literate class, non-officials as well as officials, put their backs and hearts into the work that it had been carried through in the way it had. From many sides there was evidence of the way in which numbers of people were employed for weeks beforehand in making preparations for the census. In one province there were complaints that the revenue could not be got in because the people were employed on the census, in another that the land could not be surveyed as usual, because the village officer was employed in the census, and only a few days ago a tea-planter stated that for the first weeks in January he could not get any work out of his clerks on the tea-gardens, because they were all employed on the census. All this interfered with the general business of the country, and cost a quarter of a million, and he hoped, therefore, notwithstanding what statistical-minded gentlemen might say, that India would not be troubled with a census oftener than once in ten years. With regard to the registration of births and deaths, it was stated that in some parts that was very incomplete, and so it was in some cases, but in some parts, notably in Berar, the Central Provinces, and the North-West Provinces, the registration was particularly well done. The census returns and the registrations were tested in this way—to the total for 1881 were added all the births during the succeeding decade, and from that the registered deaths were deducted, and the two results, by the census of 1891 and by the registration figures, came out within one-fifth of a per cent. of each other. According to the calculation from the registration returns there ought to have been 47,680,000 people in the North-West Provinces, and according to the census there were 46,931,000. Sir William Plowden had referred to the great increase in population. It had increased nearly 35,000,000 during the last ten years. Perhaps 4,000,000 were due to the increase of territory, and some might be accounted for by better counting, but there was certainly a clear addition of nearly 30,000,000. Going back two decades further, it would be found that the population had increased 70,000,000 during the last generation. If it went on at the same rate, by the middle of the next century the population of the Indian empire and its feudatories would have reached the enormous total of 500,000,000. Sir William Plowden ex-

pressed the belief that the people in India were, as a mass, better off than they were a generation ago. He adverted specially to Madras, and Mr. Martin Wood expressed the hope that this matter, the condition of the ryots in Madras, would be more thoroughly sifted. It had just recently been very thoroughly sifted, for there arrived by the last mail at the India-office a report by a native gentleman, a Registrar of Assurances in Madras, a very experienced and educated native official, Mr. Srinavasa Aiyengar. He had just completed a report on which he had been at work for two years, on the condition of the Madras Presidency, especially the poor classes. He had not only gathered statistics, but had taken evidence from natives all over the Presidency, and gave chapter and verse for his conclusions. He was of opinion that the population of the Madras Presidency was decidedly much better off on the whole than they were a generation ago, and infinitely better off than they were 150 years ago; yet they were often told that the people of India were very much better off under the old *regime* than under the new. There had been terrible famines during the last 30 years, and it was said that such things were not known before; but Mr. Srinavasa Aiyengar had brought out the fact that in the old times there were terrible famines, and that they caused terrible distress and loss of life. If India had been exempt from famine during the last 10 or 12 years, they could not expect such exemption to continue; but it was not necessary that Britain should take upon herself the guilt and the shame of bringing these famines upon India, for he believed the power of the country and the people to meet famine was much greater than it ever was before. This was the last meeting of the Session, and he was glad they had had so good a paper to conclude a very successful Session. When thanking Mr. Samuel Digby for reading the paper, he would add an expression of the Indian Section's cordial thanks for the energetic and wise efforts by which that gentleman had made the Session so satisfactory and so successful.

Sir GEORGE BIRDWOOD said he rose to move the vote of thanks to Mr. Baines for his most valuable and interesting paper, which he hoped would be supplemented on some future occasion by another from the same writer on the results of the Indian census. Mr. Baines, in the midst of his overwhelming duties in connection with the census, had put himself to the greatest possible trouble and inconvenience in preparing his elaborate paper for the Society, and for this alone, independently of its great intrinsic worth, he deserved their warmest acknowledgments. Beyond this, and recording his hearty concurrence in the compliments paid by the Chairman to Mr. Samuel Digby for the successful manner in which he had discharged his duties during the closing Session as Secretary to the Indian Section of the Society, he would have preferred at this late hour to say no more. But he could not help adding how deeply he resented the attacks that had been made by more than one speaker on the ignorance of the people of India, simply because their traditional culture was of altogether a different type from our own. For his part, nothing gave him more pleasure in listening to the reading of Mr. Baines's paper than the evidence it afforded that the vast masses of the historical populations of India were still, in spite of our Educational Departments, living in the ignorance of Western learning and science which is bliss, in unquestioning good fellowship with their "Gods of the Elder Days." The obstacles thus presented in India to scientific research were often very amusing. In his first medical appointment at Sholapore, it was a part of his duty to record the daily rainfall, a work in which he took the greatest interest, an interest with which his Hindu assistant seemed to show the liveliest sympathy. But gradually a zanthic tint in the gauge, and the uniformity of the daily returns, aroused his suspicions, and on inquiring closely into the matter, he found that his assistant had for weeks been playing the part of Jupiter Pluvius, out of sheer good nature to gratify his (Sir George Birdwood's) youthful enthusiasm. By a singular coincidence when in after years he had to prepare the weekly rain returns for the whole Presidency of Bombay, he found the rainfall for the Esplanade had been vitiated for years by the contributions of a favourite dog to the gauge exposed in the hospital compound of the marine battalion every monsoon.

The vote of thanks having been put by the chairman, was carried unanimously.

Mr. Baines arrived in England on the 1st June, and, having seen a proof of the discussion, has been so good as to send the following note for publication:—

Up to the middle of April, I was still in hopes of being able to leave India in time to read the paper myself; but the revision of the work in one or two provinces was not finished by the latest date which could have landed me in London by the 19th May. As regards the paper itself, I wish to point out that it is statedly about the administration, not the results of the census. I wished to include the latter, and, when first asked for a paper on the Indian census, I hoped to have been able to carry out this intention, as the main tables were already in my hands. Unfortunately, however, there were unforeseen troubles in store, connected with the floating population in Bengal and the North-West Provinces, which entailed alterations throughout the whole series of returns; and it was only in the beginning of May that I was able to finally close the totals for India. Until I had submitted the latter to the supreme Government, I did not consider myself at liberty to publish them, except in a very general form, so that I made no use of them in writing for this Society. It may be interesting, however, to set down a few of the leading features of the census results,

though I must reserve explanations for a future occasion. The population of India, then, is distributed between British territory and feudatory States, giving 221,173,000 to the former, and 66,050,500 to the latter. The Shan States roughly contain 375,000 persons, and Sikkim 20,500, excluded from the above figures, and there are sundry unenumerated tracts in Rajputana, Upper Burma, British Beluchistan, &c., which are estimated to contain about 450,000 inhabitants in addition to those enumerated. The census deals, therefore, with 287,223,000 in round numbers. Dividing them into rural and urban, we find only 27,251,000 of the latter, of whom 6,173,000 live in the large cities of 100,000 and upwards; 3,200,000 in towns of from 50,000 to 100,000 inhabitants; 4,500,000 in those of from 20,000 to 50,000; 5,500,000 in the large market towns (10,000-20,000); and 7,800,000 in towns of less population. If we exclude from the sum the towns not enumerated at last census, it will be found that the whole urban population has increased by about 9⅓ per cent. The rate is higher in the larger towns and those of middle size than in the smaller ones. Bombay heads the list, if we exclude suburbs and adjacent municipal areas, as it shows a population of 821,764; Calcutta city, with its immediate suburbs, returns only 741,144, but taking with it the adjacent towns, forming practically the metropolitan area, the population is 978,370. There is a long drop to Madras, with 452,000, and Hydrabad, with 415,000, including suburbs. In the case of both Bombay and Calcutta the tendency is just the same as in London, namely, to live in the suburbs or adjacent towns, and haunt the city only for business during the day. In Calcutta this tendency is especially strongly indicated in the census returns. In Bombay the most marked feature in the enumeration is the decrease of women, due, greatly, to the improved service of coasting steamers, which allows men to run up and down without transferring their families from their native place. I will now turn to the general variation in population, though this has been treated of already by Sir R. Temple. The return is shown in two sections; first, the nett variation, that is, the increase in provinces and States enumerated in 1881, the result being an addition of 19,294,500 to the former and of 8,526,900 to the latter. In many cases the high rates of increase amongst females, as compared with that of the other sex, is most probably attributable to the greater confidence or intelligence on the part of the householders, so that the actual increase is less than that shown by the figures. On the other hand, the details show a considerable movement in the more sparsely populated but fertile tracts of the Punjab and Central India, and the return to normal prosperity of the famine-stricken tracts of Madras and Mysore. In connection with such movements, however, I may add that the birthplace returns show little actual migration beyond the adjacent districts or States. There are exceptions, of course, as in the case of Assam, Lower Burma, and the flow from South Behar into Calcutta, and from the coast into Bombay; but the total results are that, out of 286,025,000 persons born in India, 275,115,000 were enumerated in the same province as that in which they were born, 9,481,000 in provinces contiguous to it, and only 1,429,000 in other parts of the country. As to immigration from outside, there are only about 732,500 persons returned as born elsewhere than in India; and of these nearly 580,000 belong to territory immediately contiguous to India, and 107,700 to Europe. The additions to the enumerated population which did not come under the census of 1881 comprise mainly Upper Burma, 2,947,000; Lushai, 43,600; and Quettah, 27,270, under the head of British possessions; and Kashmir, 2,543,900 of the States. Thus, the census now under review deals with about 33,386,200 persons more than that of ten years back, of which nearly 28,000,000 are attributable, for the most part, to increase in population, and 5,300,000 to accretion on the register only. The details of the variation have been well analysed in the provincial reviews that have reached me; and the real growth of the population will, ultimately, I trust, be separable from that merely due to greater accuracy in the operations. I will not burden the *Journal* with more figures at present, except to mention, as being a matter of recent interest, that the number of lepers returned is only 126,126, of whom but 30,990 are females. The only tracts in which this information was not returned are Central India and Kashmir, so the data may be taken as fairly general; and as special investigation was made into their accuracy wherever great discrepancy was found when compared with the corresponding return for 1881, I think the results may be taken to be as correct as can be expected from a non-medical enumeration. I will end these remarks by thanking Sir Charles Bernard, and other members of the Society who took part in the discussion, for the hospitable manner in which they received my paper. In connection with Sir William Plowden's remarks on the promptitude with which the population return was published, I must, in justice to him, mention that the corresponding table was issued in 1881, about six months after the census. The greater length of the interval was due mainly to the want of timely notice before the census of the need of urgency. In my case, the main object was to let officials have the return for use before the end of the year, upon which they had to report in April. Copies of the tables and returns of the census will be forwarded for the library as I issue them.

APPLIED ART SECTION.

Mr. De Morgan's paper on "Lustre Ware," read on Tuesday, May 31st, and the report of the discussion, will be printed in an early number of the *Journal*.

Miscellaneous.

NIAGARA AND ELECTRICITY.

Professor George Forbes, F.R.S., has communicated to *The Times* a letter on the extensive works for the utilisation of the Niagara Falls in the production of electricity, from which the following extract has been made. Prof. Forbes, after referring to his dreams of eight years ago, when he stood on the southern edge of the American Fall, writes:—

"And now, eight years after, I see that the preparations are almost complete for the utilisation of 100,000 horse-power, and part of this power will certainly be used long before the close of the year.

"Few people in England who have heard of this engineering feat are aware of how far it has been advanced. More than a mile above the falls a canal has been cut 1,500 feet long, at right angles to the river. A vertical shaft, 140 feet deep, is being sunk, and from a lower level a tunnel, 28 feet high, and 18 feet wide, and 6,700 feet long, has been carried at a slope of 7 per 1,000, to issue at the foot of the cliffs below the falls, just under the suspension-bridge. This work is all nearly completed. The lining of the tunnel with four courses of bricks is going on at the rate of 100,000 a day, and this rate is about to be increased. The turbines are in hand, Part of the power is to be used in factories now being built directly over shafts, and we are now preparing for the electrical transmission of power. In a year's time it is probable that the city of Niagara Falls will be lighted by this power, and the street electric railways worked by it. Factories are being erected on the vast extent of land owned by the company which has a perpetual right to use this power over five miles of river frontage from a little above the falls upwards. Already thirty acres of land have been reclaimed by the company from the river, and the river is about to be deepened in front of their wharves. A railway, five miles long, all passing through the company's land, is in hand to connect the three lines of railway with the principal factories on the company's property. This will eventually be worked by an electric locomotive. Streets have been laid out and a part has been laid aside for operatives' cottages. All this I have seen, and I recognise the foundation of an important manufacturing centre. Franchises have been obtained from owners of property for a second tunnel under the city of Niagara Falls. All this has been done, and at a surprising small cost, by the energy, caution, and foresight of the directors of the company, of which Mr. Adams is the president, Mr. Wickes and Mr. Stetson vice-presidents, and Mr. Rankine (a cousin of Professor Macquorne Rankine) the secretary. In 1890, they appointed a Commission of leading scientific men in Europe and America, presided over by Lord Kelvin. These Commissioners considered all the proposals submitted, and since then the company's engineers have dealt with the hydraulic problems. The Board of Engineers includes the names of such men as Professor Colman Sellers, Mr. Herschel, and Colonel Turrentini, of Geneva. The electric part of the work is now to be carried out. In 1890, when preparing plans to lay before the Commission, I proposed to employ alternating currents, using as motors either the alternating dynamo or the multiphase motor, which has since attracted so much attention at Frankfort last year. This was an innovation on previous practice, and it is worthy of record that the Commission were unanimous (with one exception) in desiring to pass a resolution, saying that alternating currents were not available for the purpose. Already opinion has changed, and the subsequent progress has so completely borne out the views expressed in 1890 that we are going to adopt this method.

"It may be that what I have already written may convince many of the enormous character of this undertaking. But the importance of the company's transactions has been only half told. They have lately acquired from Canada the exclusive right to use land in the Victoria-park for the same purpose for 100 years. The river above the Horseshoe Fall on the Canadian side has a branch going round Cedar Island. The power-house can be built here. Enough water can be brought through the branch to utilise 250,000 horse-power, and the tunnel from the bottom of the shaft to the very base of the fall will be only about 800 feet long. This franchise is a most valuable addition to the powers possessed by the company on the other side.

"Many visitors to the Chicago Exposition next year will stop to see the progress of this gigantic undertaking, and they will not be disappointed, and it is a matter for congratulation that, so far as the present intentions of the company go, the beauty of the falls will not be affected nor the volume of water perceptibly diminished."

PATENT-OFFICE.

The ninth report of the Comptroller-General of Patents for the year 1891 has just been issued. It shows the usual growth in the number of applications for patents, which has now reached 22,888, or 1,581 above the number of 1890. The total number of applications for the registration of trade marks was 10,787, as compared with 10,258 applications in the previous year. The revenue of the office is £203,520, made up as follows:—Patent Fees, £181,777 4s. 8d.; Designs Fees, £4,565 2s.; Trade Marks Fees, £11,034 19s. 9d.; Sale of Publications, £6,142 13s. 7d. Of this amount £103,180 was expended, leaving a surplus for the year of £100,339.

The chief items of expenditure are:—£54,267 for

salaries; cost of printing and paper, £16,600; and new works (including purchase of premises), £21,703.

The number of readers at the Patent-office Library during the year amounted to 98,477.

The report also gives information as to the other departments of work of the Patent-office, lists of the places to which grants of the specifications are made. and a copy of the "Patents, Trade Marks, and Rules" now in force.

A NEW USE FOR BAMBOO.

A new application of the stems of the larger-growing species of bamboo has recently been adopted in China for the manufacture of small trays and ornamental articles for export to Europe. It is known in China as bamboo sheeting, and it is said to be carried on at present only to a limited extent at Wenchow, where, notwithstanding that it is quite a new trade, about ten firms are now engaged in it. The process adopted is as follows:—A length of bamboo is cut off, and then pared with an axe till it is of the thickness required. It is next planed with a spokeshave, and the thin cylinder so obtained is slit up, so that, on being opened out, it forms a sheet. A number of these cylinders, placed one inside the other, are immersed in boiling water for a few minutes, to render them flexible, and they are then unrolled and flattened out, by being subjected to pressure under heavy stones. These sheets are sometimes used for making fretwork and carved screens, fans, &c.; and the small, pale, straw-coloured pin-trays, for toilet tables, which appeared in the London shops last season, are apparently made from this specially prepared bamboo. It seems to adapt itself extremely well for moulding into many forms, and might be made available in this country for various kinds of veneering. The bamboo now appears to be the *Dendrocalamus latiflorus*, and specimens of the sheeting, and articles made from it, may be seen in Museum No. 2 of the Royal Gardens, Kew.

Correspondence.

MUD BUILDING.

Mr. William Simpson always brings together on any subject he deals with, a mass of valuable and interesting matter. The one he brought before the Society is very wide in its influence, and invites some notes.

He might have broadly laid down that what he generally terms mud building extends over the eastern world and the western world, because it belongs to that epoch when the same culture and civilisation prevailed in the two hemispheres. But in America, as he says, there is a community of construction between the ancient monuments of Peru, and modern buildings reaching into California. The Spaniards did not really introduce this class of construction, for they found it in America, but they naturally kept up what they had used at home and inherited from antiquity.

Although in this connection Mr. Simpson names *adobe*, he does not name *tapia*, though he has described walling made between frames. If a material is not applied for a dwelling, it will be found in fencing, and walls and fences of *tapia* contribute as much to the development of a country as dwellings of *adobe*. Indeed, the dwelling may be of timber or stone, although the other materials are largely used.

Mr. Simpson has not set it out clearly that the adoption of building materials is governed by soil and climate, and by earthquakes. If trees are at hand, they are used, or they may be floated down by water. In a grass country, fences are made of sods, as cabins lately were in Ireland. The presence of clay and of pebbles largely governs the form of *tapia* and cobwalling, so also of lime. Small stones come in well for cobwalling.

When stones are handy, an acropolis was made, and that in Cyclopean style, without cement, as fences are now made in this country. Mr. Simpson is right that the walls of stone fortifications were surmonnted with mud structures, and, he might have added, wood. When the fortress was simply to secure cattle from marauding bands, a mud or earth wall was enough. Such were some of the Norman castles in this country, and nothing more.

The variety of the applications is very great. In many countries, as in parts of England and America still, timber is preferred, because it is held to be warmer in winter and cooler in summer. Timber is preferred in earthquake countries to mud walling and vaulting, and even to stone, although stone is sometimes relied upon to withstand shocks. As Sir Charles Wilson gives testimony, abundant examples were to be found in Asia Minor of earth construction.

With regard to cobwalling, much attention was given to it here, about 40 years ago; and to Mr. Simpson's list (p. 704) there may be added, I think, the "Civil Engineer and Architect's Journal." This material has not been despised here. It has, however, developed into concrete, and in that form has been largely used and acknowledged as an engineering expedient. In London, too, there are houses and walls built of cobwalling, under the name of concrete.

To the description of mud bricks in Egypt from M. Maspero (p. 677), I should be inclined to add that I have seen bricks prepared by simply cutting the surface mud into squares after the inundation. This appeared to me to be the primitive form, as under the heat they scaled off in flat squares.

Mr. Simpson is quite justified in affirming that earthy materials have influenced the forms of archi-

tecture, but that mud is the beginning of all would be a doubtful proposition, for the reason that local influences have their respective actions. One natural artificer who may have given an example is the beaver, a builder and engineer.

HYDE CLARKE.

32, St. George's-square, S.W.,
6th June, 1892.

Obituary.

SIR JAMES BRUNLEES.—Sir James Brunlees, the eminent engineer, who had been a member of the Society of Arts since 1858, died at Argyle-lodge, Wimbledon, on Thursday, 2nd inst. He was born at Kelso, N.B., January 5, 1816, and was educated at Edinburgh University. In 1838 he became an assistant engineer to Mr. Alexander Adie on the Bolton and Preston Railway. Subsequently, under Sir John Hawkshaw, he was occupied with the works of the Lancashire and Yorkshire Railway. He next constructed the Londonderry and Coleraine Railway, and then the works of the Ulverston and Lancaster Railway. Since that time his principal works were the Solway Junction Railway, the Clifton Extension Railway, the Mersey Tunnel Railway, and the Avonmouth, King's Lynn, and Whitehaven Docks, the San Paulo Railway, the Minas and Rio Railway, the Porto Alegre Railway, and the Central Uruguay and Bolivar Railway. He was knighted in 1886, and received from the late Emperor of Brazil the decoration of the Order of the Rose. Sir J. Brunlees was president of the Institution of Civil Engineers in 1882-83, and a member of the Council of the Society of Arts in 1876-77.

General Notes.

SOUTH KENSINGTON MUSEUM.—The gallery assigned to the large collection of wrought iron work, which has for some time been closed for re-arrangement, was open to the public on Whit-Monday, 6th inst. The larger grilles and screens, including the gates from Hampton-court, are now placed in the arched spaces on either side, while the lanterns, cressets, signs, &c., are suspended along the gallery, smaller objects being shown in sloping glass cases. Among these last is a series of rush-candle holders, tobacco tongs, and other domestic implements used in England, chiefly in the 18th century, collected and lent by Lady Dorothy Nevill. Examples of the locksmith's art, English, French, and German, are numerous, including some chiselled steel locks and keys from old French buildings, but produced by "Johannes Wilkes de Birmingham" in the 17th century. Some of the more famous specimens of mediæval work in English cathedrals have been reproduced in *fac-simile*.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 13 ... Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Albert Wollheim, "Foreign Sewage Precipitation Works."
Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Prof. V. B. Lewes, "Oil Gas." 2. Mr. Watson Smith, "The Soluble Bituminous Constituents of certain Japanese Coals."
British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 14...Gas Institute, 28, Great George-street, S.W., 8 p.m. General Meeting. President's Address, reading of Papers, and Discussion.
Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "The Brain and Muscular Anatomy of *Aulacodus*." 2. Mr. G. W. Butler, "The Subdivision of the Body Cavity in Snakes." 3. Mr. J. W. Gregory, "The British Paleogene Bryozoa."
Colonial Institute, Whitehall Rooms, Northumberland-avenue, W.C., 8 p.m. Lord Brassey, "Our West Indian Colonies; their Resources and Means of Defence."

WEDNESDAY, JUNE 15...Japan Society (at the HOUSE OF THE SOCIETY OF ARTS), 8½ p.m. Mr. Ernest Hart, "Some Japanese Industrial Art Workers."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. F. C. Bayard, "English Climatology, 1881-1890." 2. Mr. William Ellis, "The Mean Temperature of the Air on each day of the year at the Royal Observatory, Greenwich, on the average of the 50 years, 1841 to 1890."
Microscopical, 20, Hanover-square, W., 8 p.m.
Gas Institute, 25, Great George-street, S.W., 10 a.m. Commemorative "Murdoch" Lecture, by Prof. Vivian B. Lewes, "A Century of Work on the Development of Light from Coal Gas." Reading of papers and discussions continued.

THURSDAY, JUNE 16...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Prof. J. R. Henderson, "Contributions to Indian Carcinology." 2. H. B. Guppy, "The Thames as an Agent in Plant Disposal." 3. Miss M. F. Ewart, "Some Abnormal Development of the Flowers of Cypripedium." 4. Mr. R. I. Pocock, "Supplementary Notes on the Fauna of the Mergin Archipelago." 5. Lantern Demonstration.
Chemical, Burlington-house, W., 8 p.m. 1. Dr. H. E. Armstrong, "Contributions to an International System of Nomenclature: the Nomenclature of Cycloids." 2. Dr. N. Collie, "The Production of Pyridine Derivatives from the Lactone of Triacetic Acid."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W. Morning meeting.
Gas Institute, 25, Great George-street, S.W., 10 a.m. Reading of papers and discussions continued.
Historical, 11, Chandos-street, W., 8½ p.m.
Numismatic, 22, Albemarle-street, W., 7 p.m. Annual Meeting.

FRIDAY, JUNE 17...Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m.

The Telegraphic Address of the Society of Arts and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, JUNE 17, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Eighth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th June, at 4 p.m.

(By order of the Council),

Henry Trueman Wood,
Secretary.

CONVERSAZIONE.

The Society's *conversazione* will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday, 29th June.

The reception by the Attorney-General (Sir Richard Webster, M.P.), Chairman, and the Members of the Council of the Society will be held from 9 to 10 p.m.

Promenade Concerts will be given by the Band of Royal Engineers in the North Court, and by the Band of the Scots Guards (weather permitting), in the Quadrangle of the Museum.

A Vocal and Instrumental Concert by the Meistersingers and Meistersingers' Orchestra will be given in the Lecture Theatre under the direction of Mr. Norfolk Megone. The first part of the concert will commence at 9.30.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual Refreshment Buffets in the Central Corridor of the Museum.

Programmes of the musical and other arrangements will be distributed on the evening.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. The conditions under which the use of the Museum has been granted by the Science and Art Department do not permit the sale of tickets; Members will therefore not be able to purchase additional tickets for their friends, as in recent years.

The tickets are now in course of issue to the members.

Chicago Exhibition, 1893.

OFFICES OF THE BRITISH SECTION.

A view of the building now in course of erection on the shore of Lake Michigan, which is intended to serve as offices and headquarters of the British Section, is given as a Supplement to the present number of the *Journal.* The design is furnished by Colonel Edis, Hon. Architect to the Commission.

The building will be generally characteristic of the best type of English half timber houses of the 16th century, of which there are so many good examples still extant. It is proposed to use terra-cotta somewhat largely in the lower storey, with red brick facing and mullioned windows, so that the building may be a typical example of an old English house. The upper portion will be of half timber construction, with overhanging and projecting gables. As the building will be seen from all points, each façade has had to be treated architecturally. The plan forms three sides of a quadrangle with the open side next the lake, enclosed by a raised terrace with balustrade. The centre on the front or inland side will be recessed, with steps leading from both sides up the covered portico, which will open into a large central hall; off this will be, on one side, large library and reception rooms, and on the other, the secretary's office and the other rooms required for the work of the Commission. On the first floor will be a large suite of rooms and offices. It is intended to fit up all the principal rooms with wall panelling and elaborate ceilings, after the manner of some of the best English country houses. The whole of the internal fittings and furniture will be executed from Colonel Edis's designs by Messrs. Johnstone, Norman, and Co., of New Bond-street. The foundations of the building have already been commenced, and the superstructure will be pushed forward with all speed,

so as to be finished complete for the opening in May next.

Besides the necessary offices the house will contain some large rooms suitable for meetings of juries, receptions, &c., and the Commission hope that the accommodation thus provided may be found useful, not only for their own purposes, but for those of the various Colonial Commissions.

MEETINGS OF THE ROYAL COMMISSION.

A meeting was held on Friday, 10th June. Present:—The Attorney-General, M.P., Q.C., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., Major-General J. F. D. Donnelly, C.B., James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Thomas Hawksley, F.R.S., Charles Malcolm Kennedy, C.B., William Henry Preece, F.R.S., Sir Robert Rawlinson, K.C.B., Professor William Chandler Roberts-Austen, C.B., F.R.S., with Sir Henry Trueman Wood, M.A., Secretary. A meeting was held on Tuesday, 14th June. Present:—The Attorney-General, M.P., Q.C., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Michael Carteighe, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Professor James Dewar, M.A., F.R.S., Sir Henry Doulton, James Dredge, Francis Elgar, LL.D., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Thomas Hawksley, F.R.S., Alexander B. W. Kennedy, F.R.S., Charles Malcolm Kennedy, C.B., George Matthey, F.R.S., Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Robert, M.A., F.S.A., with Sir Henry Trueman Wood, M.A. Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 24, 1892; the Hon. JAMES MUNRO in the chair.

The paper read was—

THE EXTENSION OF COLONIAL TRADE.

By COLONEL HOWARD VINCENT, C.B., M.P.

The Council of the Society of Arts has been so good as to invite me to deliver a brief address upon the extension of colonial trade. I gladly respond, and the more so as within the past month the representatives of the people in the Dominion of Canada have, by a considerable majority, given a new aspect—a fresh possibility thereto.

First though, Mr. Munro, let me, as one deeply attached to the cause of colonial development, welcome you to this first, or at least one of the first, public acts of your career as Agent-General of Victoria. I esteem myself greatly honoured by your chairmanship this evening. The mother land, I am certain, is glad to see in her metropolis those distinguished sons who have upheld and carried forward the British banner in distant seas.

We have heard something of late of depression in Australia, of financial difficulty succeeding over-speculation. But you will be able to tell this gathering that with such unparalleled resources, with such boundless territory, with the riches of the surface competing with mineral wealth, passing depression may, for the hour, steady, but cannot check, the certain prosperity. The Premier of New South Wales, will, when he arrives, be able to corroborate you. Those of us who have seen with our own eyes will be friendly witnesses.

"Advance Australia" is your motto, but more than your motto. It is the command of heaven, the decree of the Creator of the universe.

Colonial Trade! Are we to consider colonial trade in its aspect of to-day alone, to weigh it only by pounds and shillings, by hundred weights and quarters of present measure, to weigh it only by our own comparative neglect, or rather want of encouragement? Or are we to weigh it by what it might have been under more favoured conditions, what it may be in the future if only common sense prevail, and the duty is recognised of developing rather our common Empire instead of wasting our millions upon foreign soils.

We can look at it in the double aspect. Some there are, I know, whose horizon is bounded by a Board of Trade return, who say that whereas the foreigner holds four-fifths of the world, and the British Empire occupies but one-fifth, and that the foreign trade is there-

fore of bigger volume than the colonial trade, it is of the former we must be mindful, even to the extent of letting the latter go by the board.

We need not fear to face the facts. What materials have we to guide us? The full data are always and necessarily eighteen or twenty months in arrear, and we all know that a much shorter time is sufficient to completely change the aspect of commerce in these days when, as Lord Salisbury put it recently, every foreign nation is engaged "in industrial warfare with protective legislation as its weapon, and its prize the markets of various countries." And who is the principal adversary? We English. Treaties and politics have been winding band after band round our limbs, and reducing us to utter helplessness. The highest political authority in the land corroborates this. Let us examine the Statement of Trade for 1890, the Statistical Abstract for 1890, the Trade and Navigation returns for 1891, and the Customs Record of the past four months.

It is true that in 1890 colonial trade with the United Kingdom amounted only to £190,000,000, whereas that between foreign countries and the United Kingdom amounted to £558,000,000. But what a different character the totals represent. In the one case we have practically complete equality between goods bought and goods sold. But in the case of the foreigner there is a balance against us of £90,000,000. In 1891 this adverse balance is increased to £126,000,000, and in the present year it bids fair to be very considerably higher. Four months' trading in 1892 show a decline of British export amounting to nearly £7,000,000, and an increase in imports of close on £4,000,000. Which trade exhibits the greatest vitality, the foreign or the colonial trade?

In 1855, we find each head of the population of the United Kingdom is buying of the foreigner to the value of £3 19s. 1d., and is selling to the foreigner £3 3s. 2d. worth of British produce. But in 1890 each head in Great Britain and Ireland bought £8 13s. 4d. worth of foreign goods, and sold but £6 4s. 6d. worth of British goods. On the other hand, the imports from the colonies have risen, in these thirty-five years, from £33,500,000 to £96,000,000; from £1 6s. 1d. per head to £2 11s. 3d., and the purchases by the colonies from £28,750,000 to £94,000,000, or from £1 0s. 9d. per head in 1855 to £2 10s. 9d. per head in 1890—or only 6d. per head less sales than purchases, instead of £2 8s. 10d. less per head, as in the case of the foreigner.

It seems absolutely clear, under such circumstances, that to the individual producer in the mother country, the colonial trade is infinitely more profitable, more advantageous, fairer in its operations than foreign trade. Of course we are all well aware of the fact that every Australasian buys nearly £6 worth of British goods, every South African brother £4 11s. worth, and every Canadian £1 9s. worth, compared to 8s. 3d. of the German, the 8s. 8d. of the Frenchman, or the 8d. of the Austrian. This is a matter of much importance to the home population.

Let us not be content, however, with looking at totals only. Let us go into details, and then we see most clearly that the argument gains greatly in force. While a considerable proportion—much more than a third—of our exports to foreign countries—a total of some £66,000,000—are composed of raw material, machines, and implements, and partially-manufactured goods, to facilitate the competition of the foreigner with us in his own and foreign markets, as well as on our own ground, upon unequal terms, that is free of the taxation the home produced article has to bear—the major portion of the colonial purchase is of goods manufactured by British labour. This is well illustrated by the following extract from the Report of the British Chamber of Commerce in Paris for last year:—

"More than half the imports from England consisted of natural products, of which nearly a third was Australian and Cape wool, while the greater part of the exports from France to England were manufactures, the produce of French labour. The value of the French manufactures sent to England was in fact within £400,000 of the amount of all the English exports and re-exports to France—food, raw materials, and manufactures combined."

Now as to the products of home labour taken by the colonies.

Of £62,000,000 worth of cotton manufactures exported, £27,500,000 worth go to the fifth of the world under the British flag. Of £24,000,000 worth of iron and steel manufactures exported, £9,000,000 worth go to our fifth of the earth. Of £2,750,000 worth of hardware and cutlery sold over the sea, £1,165,000 worth goes to British possessions.

Our fellow subjects take five times as much British apparel, haberdashery, and millinery as every foreign nation put together; three times the quantity of leather goods, a larger quantity of glass manufactures, and an equal

amount of hats, umbrellas, stationery, and steel rails. In short, while foreign flags combined only take £116,000,000 worth of British finished manufactures, the colonies and dependencies of England take £73,000,000 worth. Nothing can show more clearly the value to each individual in this country of the empire.

Then, as to the import trade, it has been admirably analysed by Mr. James Edgcome. There is an import of £88,500,000 worth of natural food products. Of these foreign countries send us practically two-thirds, and the Empire one-third, and £8,000,000 are re-exported, leaving a balance for consumption of £80,000,000 worth. There is an import of £78,000,000 worth of manufactured food products. Of these foreign countries send us all but £7,000,000 worth; £5,500,000 worth are re-exported, so that the net import of food amounts to £153,000,000. There is a large balance, though, to account for. Thereof £159,000,000 consists of raw material, and to it the colonies contribute over £54,000,000; £37,000,000 worth goes to be made up abroad, and a large proportion re-appears. But in what state? Worked up by foreigners. Close upon £57,000,000 worth of fully manufactured goods they send us free of all toll, and £50,000,000 worth remain for use in the United Kingdom. In addition there is an import of £24,000,000 worth more of foreign partly manufactured goods, making £76,000,000 of manufactured goods brought into this country from abroad, while the importation of colonial manufactured goods amounts to only £10,000,000, of which at least a third are re-exported.

It will thus, I hope, be seen that not only do the colonies buy far more of the goods made by English labour than foreign nations in proportion to their extent and population, but that which they send us in exchange competes less with our wage yielding enterprises, but rather affords occasion for remunerative employment.

The returns of the first four months of 1892 illustrate even more eloquently the growing extension of colonial trade. They show not only that the shrinkage of export, owing to recent financial depression and other causes, is much less acute as regards British possessions than with respect to foreign countries. The latter have taken upwards of £4,000,000 worth less of British goods than in the same four months of 1890, while the Colonies are only £1,000,000 in arrear. Our kith and kin have bought this year £20,100,000 worth of British manufactures, while all the rest of the world has taken but a gross total of £38,000,000, whereof about £10,000,000 was in respect of raw material, mill work, and machinery—leading to increased foreign competition with our manufactures. The real proportionate value, therefore, of British possessions to the English, Scotch, or Irish artisan, as compared with foreign countries, and illustrated by this year's trading, is as 5 is to 7—and this in spite of a policy of timorous drift.

The past four months show clearly that, as a market, without consideration of the character of the purchases, India is worth as much to the British artisan as Germany, Holland, and Belgium combined; as much as the United States, Russia, and Northern Europe combined; that Australasia is worth as much to the English mechanic as the whole of the Republics of South America; that Canada, the West Indies, and South Africa are worth as much as France, as much as Turkey, Egypt, China, and Japan put together, and more than the whole of Southern Europe.

It seems absurd, under such circumstances, to ask, Is the colonial trade worth cultivating? I put the proposition, however, in this interrogative form that the debate to be presently raised may turn upon it. For myself, as a representative of an industrial community, I do not hesitate to say that it not only presents greater commercial opportunities, but carries with it political considerations of the most vital character. There are honourable gentlemen present who will be able to offer cogent arguments for consideration upon this head. They will doubtless also call attention to the important fact that the sales of the colonies to the mother country, notwithstanding the diminished exports, show an increase for the past four months of over 16 per cent., and point undoubtedly to these islands as affording to colonial producers the best and most certain market—a market after a time they could easily supply with all the corn it demands. It is not necessary, therefore, for me unduly to dwell thereon. But it is important to consider if it will be best to leave the extension of colonial trade entirely to its natural course, or to assist it by such means as we can.

What is our position? In the first place, England is the only colonial power which does not place the commercial relations between the mother country and the colonies on a different footing to the commercial relations with foreign countries. We may be the greatest

colonial power of the day, but in the acquisition of colonial possessions we have only followed in the footsteps of Greece and of Rome, of Spain and the Netherlands. Their aim was the extension of commerce; ours was the extension of commerce. The same motive influences at this hour both France and Germany; but alone among the nations do we treat the colonies, acquired entirely by the three great qualities of the British race—courage, adventure, and enterprise—on absolutely the same footing as foreign countries. We give no advantage, we gain no advantage, over the foreigner. Is this common sense? "Does the parent build his house, establish a business, to house the stranger, to enrich the rival." Emphatically not. There is no difference whatever in the relationship between a mother country and her colonies, and that of a father to his sons.

Now what is the result of this extraordinary policy into which England has drifted—for reasons the Prime Minister has declared "we have been unable from the papers in our possession to ascertain."

I have endeavoured to set before you the importance to the mother country of its colonial trade. But let it not be assumed that because our colonial trade exhibits greater buoyancy than foreign trade, that foreign nations have been slow to take advantage of the insane limitation the anti-colonial policy of a former generation imposed on their fiscal liberty by the treaties of 1862 and 1868, which bound them to place the United Kingdom and foreign nations or one and the same footing. No, they have profited, are profiting to the fullest extent, and in the past twenty years the sales of foreign countries to British possessions have increased over 84 per cent., while the sales of the Empire to the Empire have only increased 42 per cent. or one-half the former. That is a serious matter, and although it is true that the Inter-British trade is greatly in excess of the trade between foreign countries and British possessions, the latter are gaining fast and the former receding. The last few months have seen the British West Indies compelled to give to the United States its own terms, expressed in the haughty language of superior bargaining power, although they will involve, if not discriminative, at least an increase in the duties upon British manufactures.

It is not likely that foreign powers will come to England to deprive them of their boon of commercial rank *pari passu* on British soil with Britons, and it is nothing less than pitiable to hear a British Minister declare that he can do nothing because Belgium and Germany have not volunteered to surrender the cake.

Let us look at recent events in Canada and Australia.

In the Dominion we find that practically within the past six months two pregnant messages of State have been sent to the Mother Country. The first at the end of September from the Senate and House of Commons of Canada. Relieve us, says the address to the Imperial Government, of these treaty shackles your illustrious chief declares to be so "unfortunate" and so "unlucky," your Minister of Commerce to be "relics of a past generation." Give us the power to put a lighter duty on British than on German goods.

Again, within the past four weeks, the Dominion House of Commons speaks with a voice both loud and strong.

It needed not the eloquence of Mr. Alexander McNeill, nor yet the support of M. Desjardins, that leading representative of our loyal French Canadian fellow subjects to commend this resolution to the People's House:—"That if and when the Parliament of Great Britain and Ireland admits Canadian—that is, colonial—products to the markets of the United Kingdom upon more favourable terms than it accords to the products of foreign countries, the Parliament of Canada will be prepared to accord corresponding advantages by a substantial reduction in the duties it imposes upon British manufactured goods."

That motion was carried by a great majority, and even the most impassioned of the leaders of the policy of unrestricted reciprocity and discrimination against the Mother Country had naught to urge in opposition. More than the mere figures indicated, this I say, that the people were behind that vote. I have warrant for this statement, in that in every commercial centre in Canada I have heard with my own ears the people's voice rise in support to the public platform. I have warrant for this statement, in that, eight months ago, after the death of Sir John McDonald, the illustrious author of the phrase, "A British subject I was born, a British subject I will die," the Dominion Government was upon the balance; upwards of 100 seats were being challenged or petitioned, and the majority was slender. At every bye-election the policy of trade with the mother country or with the United States was the issue, and nearly every

bye-election has added to the forces of the Government.

Why is this? Because although there are not wanting either public men or public prints who, from divers motives, are continually calling attention to the 60,000,000 of people to the south of the Canadian frontier, the loyal majority know full well, as was said in the Ottawa Chamber by Mr. McNeill:—

"Our Empress Queen is mistress of the waterways of the world. Ours are by far the greatest wheat areas in the world; ours are overwhelmingly the greatest wool areas and markets. Our empire could grow more cotton than all the cotton produce of the United States. Ours are the greatest diamond and ruby fields in the world. We are to-day first in the production of tea and of the finest coffee. In coal, iron, copper, and nickel we hold our own with all mankind. We have the greatest timber forests in the world. In sugar growing we hold a good and could hold a better place. In tobacco we come third. Every variety of climate, every variety of soil, everything that mankind can possibly require we possess in our own empire. With six times the population of the United States, with four times that of All the Russias, with that of the whole of Europe, we British subjects are not absolutely and utterly mendicant. It is not absolutely necessary that we should go cringing and whining to the back door of any foreign power to beg a little of their trade for charity. We are quite ready to trade with them, but we will trade with them on fair terms if you please. We are prepared to treat upon fair terms, but only upon fair terms, and in Admiral Blake's words, 'We are not going to be fooled by foreigners.'"

Time was, and very recently, when Australian Ministers complained that their utterances were insufficiently heard and regarded in the mother country. The complaint is likely now to be that too great importance is attached to casual observations and electoral sayings. I will not accentuate this, but simply recall the general tenour of some of the recent arguments in favour of Australsian Federation—a commercial federation on the model of that of the United States, continental free trade and high protection against the mother country and all the world.

There can be little doubt that discrimination in Canada in favour of the United States, in Australasia of commercial hostility to the mother country, must undermine the integrity of the Empire, for if it be true, as it undoubtedly is, that trade follows the flag, it is even more true that political union hangs largely upon community of commerce. There is high authority for this.

Mr. Froude has declared, "It is as sure as the multiplication table that if we do not offer Canada such a union the Americans will, and the Canadian dominion will be lost to us."

Lord Rosebery goes even further. He has said:—

"It is, as I believe, absolutely impossible for you to maintain in the long run your present loose and indefinite relations to your colonies, and preserve those colonies as part of the Empire. It is not merely commercial interests that are involved, it is a narrowing down of this country to its European possessions. Do not flatter yourselves that, if Canada and Australia were to leave you, you would retain your smaller colonies. The West Indies would go with Canada, Australia would take in Australasia, as to the Cape, I think you might make up your minds for the secession of the Cape under circumstances such as those; well, if you wish to remain alone in the world, with Ireland, you can do so."

Everything points, therefore, I submit, to the absolute necessity of doing all that possibly can be done to bring about the extension of colonial trade. I hesitate to mention the subject of foreign tariffs. But it is impossible to disregard them in considering this subject. No man can ignore the fact that the signs of the times are entirely in favour not only of the maintenance of the duties against British trade, but of their increase to a prohibitory rate on the European continent, as already in the United States and France. It is impossible for men to apply the same reasoning to their actions under such circumstances as they would if there was the faintest indication on any part of the earth to extend to Great Britain the treatment she has meted out here, to her nationals and foreigners alike, for the last fifty years. There is, in Great Britain, grave labour trouble close at hand, and it arises from what? From the fact that the pressure for existence has become so severe, that three men are seeking to do the work of one man, and subdivide his earnings. Nothing can be more certain than that neither the possession of parliamentary votes, nor trade unionism, nor the power of combination and of strikes, render the working man master of the situation, so long as the door is left wide open to bring in the product of the labour of other men, and sell it at a much lower price. This was stated categorically the other day by Lord Salisbury to the deputation upon the Eight Hours Question. I recall the words:— "The temptation to a capitalist to take his factory inside a tariff wall, instead of remain-

ing outside, is enormous. If he goes inside the tariff wall, that is to say, to the United States, or to Spain, or to France, he will enjoy entire freedom from the taxation which those countries impose upon goods, while the markets of England will be open to him as before."

Under circumstances such as these it is wholly Utopian to suppose that we are not within measurable distance of an entire economic change—of the adhesion of the governing democracy of England to the governing principle of the democracy of the world—namely, self-protection. It is therefore that I venture to urge on this learned society that upon this the seventy-third birthday of the most illustrious sovereign that has ever adorned the throne of an empire, on the fête day of Queen Victoria in the fifty-fifth year of Her Majesty's most glorious reign, it cannot do better than put forward its influence towards the extension of colonial trade, and aye. towards the commercial union of the British Empire. It has the highest authority for this—that of the Prime Minister :—

"We know that every bit of the world's surface which is not under the British Flag, is a country which may be, and probably will be, closed to us by a hostile tariff. It is to the trade that is carried on within the Empire of the Queen that we look for the vital force of the commerce of this country."

All the world now knows what additional emphasis this declaration received last Wednesday in the address of Lord Salisbury to the people of Sussex and of England :—

"We live in an age of war of tariffs. Every nation is trying how it can, by agreement with its neighbours, get the greatest possible protection for its own industries, and get at the same time the greatest possible access to the markets of its neighbours. This kind of negotiation is continually going on. It has been going on the last year and a half with great activity. I want to point out to you what I observe. Nobody cares two straws about getting the commercial favour of Great Britain. . . . . We begin by saying, 'We will levy no duties on anybody, and we declare that it would be contrary and disloyal to the glorious and sacred doctrine of free trade to levy any duty on anybody for the sake of what we can get by it.' It may be noble, but it is not business."

Nor is the Chancellor of the Exchequer behindhand.

"I must enter my protest [he has told the Commons of England] against an extreme application of the view that under no circumstances could we make fiscal arrangements with the colonies, without injuring other portions of our trade. If we find we could make the whole Empire one as regards customs, surely we have the same right of Zollverein Union with our colonies as Germany has with Bavaria, or the United States among themselves. I claim for ourselves the same right."

We have, too, the authority of the leading colonial statesmen of the day—of Mr. Cecil Rhodes, of Sir Samuel Griffith, of Mr. Service, of, I hope, the chairman, of Sir Charles Tupper, and the Canadian Ministry, voiced by Mr. Foster, the Finance Minister, in the recent Budget speech, and whose peroration I take leave to use to like end in respectfully commending to your earnest attention a subject which, in the coming Parliament, will—which must, which shall overshadow and absorb all others—be the issue before the people, come what may.

"Considering this war of tariffs, which is taking place the wide world over, considering the discriminating benefits which are given by some countries and denied by others, it may be worth the careful and thoughtful attention of the Government as to whether or not the time is not approaching, if it is not near at hand, when it will become the duty of this Government to hold out the hand of help to those that help us, to repay favour with favour and interest with interest, and to give the best treatment in our markets to those countries which afford to us the best treatment in their markets."

DISCUSSION.

Sir CHARLES TUPPER, Bart., G.C.M.G., C.B., desired first, not only in his own name, but in that of all the representatives of the self-governing colonies in London, to welcome the Chairman, who by his high character and great ability had obtained the confidence of the people of one of the most important colonies in Australasia. He had no doubt that he would be able to render the same valuable services to his country and to the empire in his present position as he had done in Victoria. Colonel Vincent had so completely covered the ground in the paper as to leave very little more to be said. He had referred to that being Her Majesty's birthday, and in thinking of the immense advance made by the British Empire during the present reign it was but right to call attention to the fact that great as that advance had been in every portion, in no part had the progress been greater than in Her Majesty's colonial possessions. The course advocated by Colonel Vincent was making steady and marked progress, though in a conservative country like England one could not look for such rapid action on the part of the public as in newer and more enthusiastic countries. Still, having watched closely the progress of events, he was

satisfied that this great movement for uniting together in closer bonds, by means of the universal tie of self-interest, the mother country and the colonies, was making rapid headway. What progress and prosperity might not colonial development have attained had not the Machiavellian policy of some astute Belgian or German outwitted the British Government long ago, and succeeded in putting these manacles round the country which prevented the fostering of inter-imperial trade. Too much importance could not be attached to the advantage of relieving England and her colonies at the earliest possible moment of these obstructions. He did not believe the difficulties were so great as some supposed, and that all that was necessary could be done without doing any injury to the general trade of the country. The trade returns showed that it was not England which was deriving a profit from the trade with Belgium and Germany, but those countries themselves, and therefore the objectionable clause might be eliminated without danger of interfering with other portions of existing treaties. It was established beyond controversy, that however beneficial trade with foreign countries might be to England, it was infinitely more beneficial to develop trade with the colonies. But there was another point, not specially dealt with in the paper, which, in his judgment, out-weighed even the commercial advantages of such a policy, England possessed in Australasia, South Africa, and Canada, boundless fields for development, which could not be rivalled in any part of the world, and thus had not only the opportunity of building up an enormous and valuable trade, but, as the result of that, those great outlying possessions would become the right arm of English power. There need be no apprehension with regard to their neighbours on the great Continent of America if, under the development of this inter-imperial trade between Canada and the mother country, population and industry were thrown into that great Dominion, which would furnish happy and comfortable homes for from 40,000,000 to 100,000,000 of people at no very remote date. They were all indebted to Colonel Howard Vincent for the ability and energy which he devoted to this great work, both in and out of Parliament, and he had no doubt that, at no distant day, his efforts would be crowned with success.

General LAURIE said he was only entitled to speak as a late member of the Canadian Legislature, and as Sir Charles Tupper had already spoken on behalf of Canada, he should not be justified in taking up time by going over the same ground. They were indebted to Colonel Vincent for pressing this great question in season and out of season—if, indeed, it could ever be out of season to press the importance of inter-imperial or international trade. He preferred the latter word, because the word imperial had an unpleasant sound to many in the colonies, who thought it implied an overshadowing of the colonies by the mother country. He knew that was not the intention of those who used the term; the object was to build up one great nation, to use every means, and especially to add the force of self-interest to that of sentiment, in order to do so. What Lord Salisbury said at Hastings about Canada would equally apply to Australia; it was essentially a union of hearts, but they desired to strengthen that union by the ties of self-interest. Colonel Vincent's appeals had met with a hearty response in the Canadian Parliament, and he hoped an expression to the same effect would come from Australasia. True, they had other questions to decide there, and it seemed to him that a union of the Australian colonies must precede a fiscal arrangement with the mother country; but a fiscal union would not be practicable. The colonies had to raise their revenue in their own way, to meet charges for the development of their own countries, and so on, but a preferential arrangement between themselves and the mother country, freed from the fetters of the treaties to Belgium and the Zollverein of Germany, so that they could make their own tariffs, and give Great Britain an advantge in the colonial markets, and possibly obtain similar advantages in the home markets for their produce, would be the means of drawing closer the ties between the great branches of the Anglo-Saxon race. They held already such a position in the world as would enable them, if so united, to exercise a commanding influence over the policy, and in fact over the actions of the whole world. Colonel Vincent had shown that the colonial trade was of the greatest possible value, that it would become of growing value if fostered, and that it met the decline of trade with other countries, and he believed that his proposals would commend themselves to the British electorate.

Mr. C. M. KENNEDY, C.B., said—We are very glad to welcome Colonel Howard Vincent in this room to-night, and have listened with much interest to his paper. His best exertions have now been devoted for many years to objects of the greatest importance to the working-classes of this country; and of vital consequence to the welfare of the whole empire. This subject has been brought before us very opportunely: the questions at issue are now in men's minds; the export trade of the country is our great concern—all our interests depend on it. In a month's time a general meeting of the Chambers of Commerce of the empire is to be held in London; and the suggestions which will be the outcome of their deliberations are awaited with no ordinary solicitude. The position of the empire—of the mother country and of the colonies—is marked out for us by the conditions of our life: we are component parts of one race and nation, and the welfare and greatness of the whole is inseparable. Much is now said in certain quarters against the economic policy of some of the colonies. But there is little in these remarks—they are often of that description of sympathy, which is likened to mustard without beef,

or else they arise from *doctrinaire* ignorance of the actual position of the colonies. In the early days of a State, internal revenue is not to be depended on, large direct taxation is out of the question, and a Customs' tariff is a financial necessity. Even in settled countries, the Customs is a branch of revenue which it is not within practical policy to discard; and to speak against Customs' duties in the colonies, and to try to create prejudices by vague denunciations of what is called protectionist policy, is, to use a very mild statement, a misrepresentation of facts. We must remember that economic theories are not universally true; they are only true under the exact application of the conditions which they postulate, as Professor Marshall says, "in a very narrow range of circumstances, which happen to exist together at one particular place and time." And we must remember, further, that men understand their self-interests very differently in different ages and conditions. So we need not be afraid of independent judgment, and may set aside boldly asserted *doctrinaire* opinions, put forward under the sound of great names, which we are told must not be discussed but be accepted implicitly, without any inquiry or question on our part. With regard, however, to what Colonel Howard Vincent has said as to the attitude of Her Majesty's Government, no one can fail to recognise that the questions which he has brought forward have to be regarded from various points of view, and that, in some respects, they present considerable difficulties; he is, therefore, under a misapprehension in thinking that there is any want of good-will on their part. The important question before us this evening is well within our functions. We are the Society for the promotion of Commerce as well as for the advancement of Arts and Manufactures; it is quite within our functions to consider the means whereby markets now open to our trade may be made more secure, and the means whereby the obstacles which hostile tariffs interpose to its development may be overcome. Colonel Howard Vincent has foregone the ease which wealth and position afford in order to attract attention to the matters of deep public interest. He has visited the colonies to obtain personal knowledge of the subject he has brought before us. Many economists, however, shrink from these investigations, and use hard words instead of arguments. I do not wish to enter into details of controversy, but in view of forthcoming discussions I may advocate free inquiry and a full statement on each side of the points at issue. We cannot fail to recognise that Colonel Howard Vincent seeks to attain objects which will strengthen the development of the empire in the present glorious reign, which are calculated to bind together the various populations of the empire, and to promote and perpetuate their welfare as a prosperous, contented, and united people.

Mr. H. J. Pettifer said all parties were agreed as to the desirability of encouraging trade with the colonies, that it would be a grand thing for this country, and probably for the colonies also, if the trade could be very greatly extended; but the difference of opinion arose when one began to talk about the best way of doing it, and he should have liked Colonel Howard Vincent to go a little more into detail about it. It was not the disease that needed discussing, but the remedy. Everybody agreed that the country was injured by foreign competition, but directly you began to talk about putting a duty on silks, satins, velvets, &c., the trouble began. It was very easy to get the working men in the large manufacturing districts to agree to preferential duties in favour of colonial, as against foreign, products, &c. You could show them how they would benefit by it, but then you had to go to the English farmer, and show him how he would benefit. He had tried that himself, and had spoken of preferential duties on Canadian and Indian wheat; but the farmer objected that, if he were going to be ruined by foreign competition, it did not matter to him whether that competition came from Canada or the United States. Still, you might convert even the farmer, if you could show him that, by imposing preferential duties, the burden of taxation which he now had to bear would be lessened. But then you had to go lower down, to the man who now, whether for good or harm, had the control of the country in his own hands, the agricultural labourer, and there you found the real difficulty. When you came to talk to the Wiltshire labourer with his 10s. a week, you had great difficulty in exciting any enthusiasm in him about the colonies, the only thing you could impress upon him was that it would give him a better field for emigration. But then both sides wanted to stop emigration, and district councils and parish councils were talked of as a means of helping him in his own village. The spirit of patriotism had not much force, he was afraid, amongst his class. He hoped Colonel Vincent would go a little more into detail as to the means for developing the colonial trade.

Mr. A. K. Donald said he was disinclined to believe that the best way of encouraging trade in the colonies was to set up a tariff barrier against other nations, and doubted whether the increased trade with the colonies would counterbalance the falling off of commerce with other nations. Many people asserted that the goods supplied by this country were not what they ought to be, owing partly to lack of technical education on the part of the workmen, and partly to unscrupulous greed on the part of manufacturers, and that consequently colonial customers preferred to buy elsewhere. A hostile tariff against continental nations and the United States would not make the British manufacturer more honest, and consequently the colonial customer would in all probability still prefer to make many of his purchases where he did now. Though it was true that trade in the colonies was growing rapidly, it could not be assumed that it would con-

tinue to grow at the same rate. The colonies did not pretend that their tariffs were imposed for revenue purposes only, but acknowledged that they were for the purpose of protecting and fostering their own industries. The colonies were endeavouring to become—as all countries ought to be—self-supporting, able to produce everything they required within their own borders. That being the case, it seemed to him that the real problem was not going to be permanently solved by endeavouring just for a time to foster the colonial trade. The real way to face the difficulty would be to find some way to make England herself self-supporting; and though that might sound ridiculous to some people, there were a number of authorities who maintained that under a better system of cultivation we could enormously increase our production of food. It seemed to be assumed in the paper that goods which came here from France or Germany came gratuitously, nothing being sent in exchange for them; if that were not so, he could not see how it was to the disadvantage to exchange commodities with those countries. It was quite true that English capital made waterworks aud tramways abroad, and the profits on those investments which were imported here did not directly represent an exchange of labour, but he did not suppose Colonel Vincent suggested that a present should be made of those public works to the communities for which they were constructed. The exchange which took place between England and any other country might be quite as beneficial to English labour as that which took place with the colonies. It was all very well to say that more labour was put into goods sent to the colonies than into those which went to the continent, but were they to refuse the continental trade altogether because it was not exactly what they wanted. From France we received a large amount of millinery and other things desired by the feminine part of the population, besides wines, &c., and he feared it would be rather difficult to replace these articles by goods from Quebec or Montreal; they would not be appreciated by London ladies. But that was what it must come to if these proposals were carried out in their entirety. He could not tolerate the miserable pinchbeck, so-called patriotism, and talk about our kith and kin. After all flesh and blood in France, Germany, or Belgium, was flesh and blood still, and those people were of as much interest to him, though they might not be his 99th cousins, as people who lived in Tasmania or the West Indies. He hoped the people of this country would never again be made enthusiastic over these old-fashioned worn-out ideas; but that their sympathy would be as wide as the human race itself.

Mr. Stephen Bourne said that the paper was extremely interesting and useful, though he could not altogether agree with its scope and effect. No one could appreciate more deeply than he the importance of our colonies, and his experience of them dated back to a time before Her Majesty began to take any part in Imperial matters; it had ranged over a large part of the British Empire. He had relatives in several colonies, and never faltered in his belief that the source of England's greatness would be found in the support of her colonial possessions. Notwithstanding the remarks of the last speaker, blood was thicker than water, and he thought we ought to give our first consideration to the welfare of our brothers, sisters, and cousins in the various portions of the empire which they had brought under British sway. But there might still be a question, what was the best means of effecting this end? He would not criticise the figures on the spur of the moment, or attempt to draw a different lesson from them, but he could not help feeling that they had not yet got to the bottom of the matter. Colonel Howard Vincent, while enhancing the value of the colonial trade, seemed to ignore the value of the foreign trade. Though the colonists were large purchasers, the exports to them, to a great extent, represented investments of capital transferred there from England in the shape of goods; and therefore, unless we sent a larger amount of capital to the colonies, we were not likely to increase the colonial trade to a great extent. In fact, any such extension as was fostered by differential duties, would be more than compensated for by the loss of foreign trade which would result from it. The great need of the colonies was, first, capital to develop their resources, and then population to work them. He had always contested the notion that this country was overpopulated; the fault lay in our economical conditions, which did not permit of our properly distributing that population over the empire. His experience of the colonies taught him that the result of differential duties would be to divert a large amount of colonial labour from its legitimate occupation in developing the natural resources of the country, and sending their products to us in exchange for manufactures, thus becoming competitors with our own capital. Some years ago, when he visited Canada, he found heavy differential duties levied against English cotton manufactures. He had always been of the opinion of Lord Meath, that what we wanted was an extensive State system of colonisation, helping to remove those who would be useful on the other side, but were overcrowded here. He did not advocate sending paupers abroad, but if we sent a large number of those who were above the rank of paupers, we might save many more from degenerating into that condition. If one-half of the £8,000,000 squandered in the maintenance of lives comparatively useless here were spent in transporting them to our own colonies, we should benefit ourselves and the colonies likewise. If there were plenty of labour and capital, trade must follow its own natural course. Why was it that Englishmen going to the United States with capital and machinery, or to other foreign countries, were not able to compete with others? He was tired of

hearing that Englishman needed protection, and did not think a country like England ought to stand in need of protection from any country in the world. Look at tea. In his early days, China was the source from which tea was derived; but, under perfectly free trade, our own India and Ceylon tea had practically driven it out of the market. Then take the meat trade of New Zealand—where he had a son, and was therefore much interested in it—that had very largely developed, without any protection at all in this country. If New Zealand would take our manufactures in exchange for their meat, instead of setting up manufactories of their own to compete with us under differential duties, that trade would rapidly increase, and, in proportion as it grew in accordance with natural and not artificial laws, it would contribute to the prosperity of both countries. It was quite clear the tendency of the paper was that we should follow the example of America, which permitted perfectly free trade between all the territories in the Union; and, so far, he agreed with it. There ought to be a uniform tariff for all parts of the empire, and the question between him and Colonel Vincent would be, whether they ought to supplement that by imposing differential duties against foreign nations? He did not think that would produce the grand results which Sir Charles Tupper seemed to imagine. The great growth in the colonial traffic had taken place under free trade, and we had become carriers for all the world through free trade in shipping. If we confined our trade to the colonies, we should lose a large amount of profitable employment. At the same time he never shared the sanguine views of Cobden, that when we introduced free trade the whole world would follow our example, and thought a great mistake was made at that time. There was a tendency at present to draw a restrictive line against England, and that should make us withdraw our capital from foreign countries, and place it in our own colonies. But there was another reason why protection abroad was largely supported by those who were free traders at home. Some of these men had large capital invested in protective countries, and drew large profits from protected manufactures there. The establishment of free trade in the United States would be the severest blow which could be levelled against the manufacturing industry of Great Britain, and from that point of view he was inclined to hope that it would be long before she adopted it. Still no doubt we were suffering from the effect of protective duties, and it was a question how we could counteract that. He felt we had a right to say to foreign countries that if we admitted their goods free, we insisted on being placed on equal terms. Free trade with all the world was the goal to aim at; if protection were carried out all round, it would enhance cost everywhere, and do no good to anyone; but we had a perfect right to say if you do not accept the hand of friendship which we hold out to you, we will withdraw it. Such a policy could have been carried out without difficulty when Sir Robert Peel first introduced free trade, but he doubted if it was possible now. Still, it was well worth inquiry. Twenty years ago, if we had refused to admit French wines and silks free unless she admitted our woollens and cottons on the same terms, it might have been done, and even now he believed the trade was far more important to France than to England, and that they might be brought to reason. It was in this direction he should be inclined to proceed, rather than by imposing preferential duties in favour of the colonies. He looked forward to unrestricted intercourse between the whole world, and then our trade would be vastly extended, with our colonies and with other countries as well.

The CHAIRMAN, in proposing a vote of thanks to Colonel Howard Vincent, said that he had learned a great deal from the paper and the discussion. He came from a colony where though there might be individual free traders, he was quite sure that no one would have a chance of being returned for more than one or two constituencies who stood on free trade lines. The allusion made to the Queen's birthday reminded him of the fact that the colony he represented was younger than himself by four or five years. When he was born no white man had ever stepped, with a view of remaining, on the territory of Victoria. The whole of Australia was comparatively young, but it was a remarkable fact that the imports and exports of Australia to-day were greater than were those of Great Britain when the Queen ascended the throne; and, that being so, what could be hoped for in the future. One gentleman had said that he did not see why they should not treat Belgians and Germans in the same way as their own kith and kin in the colonies; but he could give one very important reason why they should be treated something differently. There was not the least prospect, under any circumstances, of the colonies ever going to war with England, but there was a possibility of the most friendly foreign nation going to war, and if that time ever came, the colonists, would be England's warmest friends; they were as loyal to the British crown in Australia as they were in England. He did not believe, as Mr. Bourne did, that there would ever be free trade all over the world; he did not think it possible, considering what human nature was. Each colony must look to its own interest. They had heard of agricultural labourers in England getting 10s. a week; he did not know of anyone in Australia, who was worth his salt, who got less than 6s. a day, and how was it possible for the man who paid 6s. a day for his labour, to compete with him who only paid 10s. a week? The man who paid higher wages must protect himself against the competition of cheap labour. Then another most important question was the value of capital. In London, he found you could discount a good bill for three months at about 1 per cent.; in Melbourne, he could not get the best bill discounted for three months for less

than 6½ per cent. If one man could borrow money at 1½ per cent., and the other had to pay 6½, how could they compete on equal terms in the same market? Another important point was that of local federation; he thought it was absolutely necessary to have a federation of the Australian colonies before they could come into union in any way with the home authorities. At present, Canada spoke with one voice for the whole Dominion, but he could only speak for about one-seventh of the colonies of Australia. Where every colony had its own particular policy, it would be very difficult to get unanimity. When federation was established, they would all speak with one voice, as Canada did now. A year ago, in February, when they had a meeting in Sydney, he thought they were in a fair way of getting federation, he having been the convener of the gathering; but it was found there were difficulties in the way, and at present they were not advancing much in that direction. Of course the next thing would be to have free trade amongst their own colonies, but they would undoubtedly have a protective tariff against the outside world, including Great Britain. It might be possible, in the course of time, if Canada took the lead, in giving Great Britain the benefit of preferential duties, and the effect was beneficial, that Australia would follow the example. This paper put the matter from a different point of view to that from which it was approached in the colonies. They felt that while a few years ago they were encouraged, and considered, there was now a spirit of hostility abroad against them, especially in the financial world, and the financial press was advising people to lend their money to South America, Greece, or any country rather than the Australian colonies. If they had ever even hinted at repudiation, or made default in the payment of interest when due, he could understand it, but they had always fulfilled their contracts in every particular. There was recently a general election in Victoria, and all sorts of candidates came forward; a number of labour candidates, and even some Socialists, but there was not a suggestion in any reported speech of anything approaching to a repudiation of their financial engagements. They felt, therefore, that they were not being done justice to, and that if England wanted the volume of trade extended, she must be a little liberal in advancing capital when it was required. Every shilling of money lent by England was spent in English goods, and it all went to develop the resources of the country. They had spent large sums in constructing railways which were not, and could not be, immediately reproductive, but indirectly they were, as they raised the value of the land from 10s. up to, it might be, £5 an acre. This year a large quantity of wheat was being sent to England, whereas but for the railways they would not have been able to supply even their own population. With regard to emigration, it was sometimes complained that they did not spend some of the borrowed money in importing labour. He did not know what the working classes in England would think of it, but certainly in Australia they would not think it right to tax their constituents for the purpose of paying the passage of other working men to come and compete with them. They were ready to receive all who came at their own expense, but they would not spend the public money in bringing them. They considered they did their duty in employing the people at fair wages and giving them an opportunity of earning a good livelihood, and making provision for old age. There was no Poor-law, and they were anxious not to have one, though there were people requiring assistance occasionally. He should take care to send copies of this paper to Victoria, where he was sure it would be read with interest and instruction, but he was not sanguine as to the views it contained being speedily adopted. He was sometimes astonished at the way in which free trade had gone mad in this country. A few years ago, when in Scotland, wanting to buy a purse, he was told by the shopkeeper he had not one which would suit him, but he should be having a case in shortly from Belgium, where they were made much more cheaply than at home. A few days after, wanting to go into the vegetable market in Edinburgh, he was charged halfpenny admission, and if he had gone earlier would have been charged one penny. Now, to buy a Belgian purse without being taxed at all, and to be charged a penny for buying a cabbage grown on the spot, was a sort of free trade which an Australian could not understand at all.

The vote of thanks having been carried unanimously,

Colonel HOWARD VINCENT, in reply, said it was too late to deal with the various arguments which had been put forward in the discussion, but he might incidentally answer Mr. Pettifer, who probably had more experience in addressing audiences of working men than any one present, in replying to Mr. Donald. The view of the United Imperial Trade League, and of Sir Charles Tupper, and many other able and prominent men, was this. The mother country required certain articles of food and raw materials which were obtainable within the empire, but not in sufficient quantity within the British Isles, and they claimed that we should give our custom, as far as possible, to those who traded with us, rather than to those who would sell us their goods, but declined to buy ours. This state of things did not apply fifty years ago. The colonies were then almost an unknown quantity. But in that fifty years, by means of steam and electricity, the products of the colonies were brought more readily to hand than the produce even of the extreme corners of our island at that time. The cause of the displacement of Chinese tea by India and Ceylon was that in the one case all the resources of modern science and machinery had been applied, and in the other these things were entirely neglected. Besides, tea,

which was an article of daily consumption, was enormously taxed, and as it could not be produced in this country, the whole of the duty had to be paid by the consumer and not by the producer. He had been glad to hear what was said by the Chairman as to Australia. Those who had been there knew that there was no probability of Australia repudiating her public engagements. With regard to the theory of establishing free trade with all parts of the British Empire, to any one who knew anything of the colonies, it was almost an impertinence to suggest that young scattered communities could obtain the necessary revenue by any other means than indirect taxation. If they attempted to send round an income-tax collector, as in England, to inquire what profits every one was making, it would produce a perfect revolution, and once setting the match to such a flame, no one could say where it would end. It was impossible to dictate to the colonies what fiscal policy they should pursue; but if there was found to be a willingness to put a lighter duty on British goods than on the products of foreign nations, that would be of considerable advantage to England, and in return for that advantage we ought to give an advantage to colonial products in English markets, and to buy of them as far as possible, instead of from the foreigner; to take our wheat from Canada rather than from the United States and the same with other articles, rather than from France, Germany, or Spain, which only allowed our goods to enter on exorbitant and almost prohibitory terms.

Sir JOHN ROBINSON, K.C.M.G., writes:—Owing to the length of the discussion and the lateness of the hour, I had not an opportunity on Tuesday last of adding my quota to the tribute of just appreciation paid to Colonel Howard Vincent by various speakers for his admirable and instructive paper upon "The Progress of Colonial Trade." Representatives of Canada and Australia did so in fitting terms. As a South African colonist, I should have been glad to have supported what they said. It is very satisfactory to us, as colonists, to find eminent home politicians ready, as so many are, to recognise the value and importance of colonial trade. Twenty-three years ago (May 19, 1869) it fell to my lot to read before the Society of Arts a paper on "The Progress of the British Colonies." I endeavoured to show, by figures, culled from authoritative sources, how vast had been the expansion of colonial trade, industry, and civilisation during the preceding quarter of a century. At that time, to speak on such a theme was rather like a cry in the wilderness, but the results I was able to show were, at the time, deemed remarkable, if not startling. The figures submitted by Colonel Howard Vincent the other night, show that the ratio of advancement has been, during the subsequent period, even more surprising. Have we any reason for supposing that the pace will slacken? Have we any reason for believing that trade will cease to follow the flag as long as that flag flies? I say nothing here with regard to the political and fiscal questions raised in the paper, and dealt with during the discussion. Enough was said to show that they involve complex considerations not easily disposed of. All the more reason why the discussion of them should be seriously and deliberately proceeded with, and all the more credit to Colonel Howard Vincent for challenging controversy upon issues so momentous to our race and Empire.

Mr. JOSEPH ROBT. CARTER, F.S.S., writes:—As a humble follower of Richard Cobden, it appears to me that by our example we must demonstrate to the world how vastly superior are our own prospects under free trade than under protection—which we have also tried—and to look forward to the not far distant future when the spread of true economic views throughout the world will be accompanied by a demand from the colonial democracy against being "protected" by tariffs that hinder them from competing even with the effete but free workers of the mother country. It is clear that were we to attempt to dictate even to our own self-governing colonies, much less to foreign nations, our intentions would be mistaken and our aims frustrated. We must not forget that, as Mr. Munro candidly admitted, even a federated Australia would probably treat us—like foreigners would be treated too—to heavy custom duties. Self-interest, as interpreted by each country, will remain the chief motive power in fiscal arrangements. And the lesson will not have been misread by ,, ethinking portion of our colonial brethren when they realise that Great Britain is firm in her belief in the expediency as well as the justice of free trade principles. He would, indeed, be a true friend to his country who persuades her not only that it is useless attempting to convert Great Britain from her free trade tenets, but also that a serious injury is being done to his own colony so long as it hobbles along with the broken crutch of "Protection." If we look, however, at the record of our foreign trade for the past fifteen years, as given in the Statistical Abstract, we find that the value per head of exports of British produce from the United Kingdom was in the latest year greater than at any previous time:—

	£	s.	d.			£	s.	d.
1876..	6	0	10	....	1884..	6	10	6
1877..	5	18	6	....	1885..	5	18	4
1878..	5	13	8	....	1886..	5	17	2
1879..	5	11	8	....	1887..	6	1	4
1880..	6	8	10	....	1888..	6	7	3
1881..	6	14	0	....	1889..	6	14	0
1882..	6	17	2	....	1890..	7	0	8
1883..	6	15	4	....	—			

It is to be regretted that an analysis of that trade should show that the progress thereof with British North America and Australia, for example, more particularly the former of our possessions, as compared with our export trade with the United States, does not exhibit that unmistakeable character which those

who talk about "trade following the flag" would lead us to hope and expect:—

	United States.	Brit. N. America.	Australia.
1876..	16,833,000	7,358,000	17,681,000
1877..	16,376,000	7,613,000	19,285,000
1878..	14,552,000	6,436,000	19.573,000
1879..	20,321,000	5,445,000	16,270,000
1880..	30,856,000	7,708,000	16,930,000
1881..	29,796,000	8,410,000	21,377,000
1882..	30,970,000	9,699,000	25,365,000
1883..	27,372,000	9,155,000	24,216,000
1884..	24,426,000	8,652,000	23,895,000
1885..	21,993,000	7,206,000	25,166,000
1886..	26,824,000	7,894,000	22,395,000
1887..	29,547,000	8,108,000	19,769,000
1888..	28,897,000	7,572,000	25,477,000
1889..	30,293,000	8,141,000	22,879,000
1890..	32,068,000	7,225,000	23,006,000

Miscellaneous.

THE PRODUCTION OF APRICOTS IN DAMASCUS.

The city of Damascus is surrounded by gardens which are composed of fields of apricots furnishing an average yield of from 50,000 to 65,000 quintals of fruit. M. Guillois, the French Consul at Damascus, says that the harvest lasts about six weeks, generally from the 10th June until the end of July. There are six principal descriptions of apricots, the *Sendiani*, *Hamoni*, *Onazari*, *Chahmi*, *Baladi*, and *Klobi*. The *Sendiani* appears the first, about the middle of June; it is an oval fruit of a yellow colour, and of a slightly acid taste. It is consumed exclusively at Damascus. The kernel of this description of apricot is not bitter to the taste. The *Hamoni*, which follows immediately after the *Sendiani*, is the most appreciated; it is small, round, with a glossy skin, and the fruit is perfumed and juicy. This variety, like the former, is consumed at Damascus, and it is subdivided into two categories, the *Hamoni Bakir* and the *Hamoni Lakisse*. The *Onazari* is slightly oval, red, juicy, and perfumed, and resembles the European apricot. The kernel of this description is large, and of a sweet taste, and is easily detached from the fruit. The price of the *Onazari* is about a sixth higher than that of the preceding varieties, and part of this fruit is consumed at Damascus, and the remainder is sent to Beyrout. The three varieties enumerated above are almost entirely used for home consumption, and in a fresh state; while the following descriptions are largely used in the manufacture of preserves, for drying, and for making apricot paste. These are the *Chahmi*, which, externally, resembles the *Hamoni*, but is inferior to it as regards taste, the fruit being dry, and wanting in perfume. The *Baladi*, which resembles the *Onazari* in form and taste, is yet considered to be superior to the latter. The yield of this fruit is about 5,000 quintals, and of this quantity 1,000 quintals are consumed in the fresh state at Damascus, the remainder being used for making dried apricots (*Noukou*), which form one of the principal articles of export from Damascus. This fruit is gathered from the tree when it is completely matured, generally about the 15th June. It is then exposed for three days to the sun on planks, covered with a layer of long straw, care being taken to keep the apricots apart, so that they may not touch one another. The third day, each apricot is gently pressed between the palms of the hands, and again exposed to the rays of the sun, and this operation is repeated until the fruit, perfectly dry, assumes the shape of a flattened disc. This usually takes place in about six or eight days, and the apricot loses about 70 per cent. of its weight. The price of the dried apricot varies between 30 centimes and 1 franc the kilogramme at the time of drying; but at other times, and particularly in the month of Ramazan, when there is a large consumption of the article, the price is doubled. A small quantity of these dried apricots is used in the manufacture of preserves. The remainder is exported to Egypt, Smyrna, and Constantinople, to a value of about £3,200. The *Klabi*, which is a very inferior quality of apricot, is a small, dry, red fruit, and is the only one in which the kernel is bitter. It is exclusively used in the preparation of apricot paste. Apricot paste, known as *Kamar El Dine*, is together with dried apricots one of the principal exports from Damascus. The fruit, when gathered, is crushed in a kind of large iron-wire sieve, and the thick juice which results from this operation is collected in earthen vats, and then spread on planks covered with a layer of oil, where it is allowed to remain two days exposed to the air. At the expiration of this time, the paste is removed and turned. On the fourth day the paste is again removed, and it then has the appearance of a band of leather, very thin, and of a reddish-brown colour, about a yard and a half long and half a yard wide. This is the finest quality of paste. The same operation is repeated once or twice to obtain a second and third quality, each time a little water being added to the residuum of the former operation. The bands of paste are then folded so as to form bundles of about five pounds weight, which are sold according to quality—from 35 to 55 francs the quintal. In the same way as dried apricots, apricot paste is exported to Egypt, Arabia, Aleppo, Constantinople, and also to Belgium. The value of the export amounts annually to about £14,000. As regards the kernels of the apricots, part of these is consumed at Damascus in the manufacture of oil, and the remainder is shipped to France, Germany, Italy, and Austria, the value of this export trade being estimated at £8,000. The value of the yield of apricots in Damascus, after allowing for expenses, is estimated at £28,000. These figures, says M.

Guillois, are sufficient to show the importance of apricot culture in the immediate environs of Damascus, and in his opinion they might be doubled, if an improved system of culture and irrigation were adopted.

THE MINING INDUSTRIES OF NEWFOUNDLAND.

The Colonial Secretary of Newfoundland, in a recent report to the Colonial-office, says that, owing to the absence of roads through the interior, mining is still confined to within a mile or two of the sea coast. The mines worked during last year were for copper ores, antimony, iron pyrites, and galena. The mining industry may be said to be yet in its infancy. The country gives promise of immense scope in this direction. Ores of antimony, zinc, molybdenite, chromite, nickel, hematite, gold, silver, &c., are all known to exist, while of the earthy minerals and non-metallic substances there are great varieties, and in many cases an abundance of material. Marbles, granite, slates, serpentines, ornamental stones, sandstones, limestones, soapstones, and gypsum abound; and asbestos, fluor spar, graphite, mica, &c., are all found there. Clays, suitable for the manufacture of brick and coarse pottery, are abundant. During the past year valuable seams of coal have been discovered in the vicinity of St. George's Bay. Previous to this, the St. George's carboniferous area was generally thought to be destitute of workable coal seams, and as being occupied almost entirely by the lower measures, namely, the carboniferous limestone and millstone grit series. Certain of the fossil plants, and samples obtained during the year, were referred to Sir William Dawson, principal of McGill University, in Montreal, and he gave it as his opinion that the specimens sent indicated a development of the coal measures not unlike that of Eastern Cape Breton, with which the beds may be connected under the gulf; and he stated that the Government of the Colony would do well to inform the English Government of the value of the coals on the west coasts, and their prospective importance to Britain and Newfoundland as well as to the other colonies. He added, "you have the nearest coal to England on this side the Atlantic." An investigation in the section of country referred to has brought to light 27 feet of coal, which is but 10 feet less than that of the North Sydney section. The analysis of this coal gives a per-centage of carbon not inferior to that of Cape Breton coal. This, together with the large deposits of magnetite existing in the same locality, cannot fail, says the Colonial Secretary, ere long, when capital and skilled labour are brought to bear on them, to add greatly to the prosperity of Newfoundland.

HOP GROWING IN BOHEMIA.

The United States Consul at Prague, in a recent report, says that large breweries all the world over always keep in their storehouses at least a small quantity of Bohemian hops, although the price paid is frequently a high one. This fact is a high tribute to the excellence of the Bohemian product, the superior qualities of which are attributed to peculiarly favourable conditions of soil and climate, and to careful and well-tried methods of culture. Since the sixteenth century, hops have had their home in Bohemia, and their fame, then already established, has been maintained and increased, and hop growing still continues to occupy a position of the first importance among the various forms of agriculture. The hop gardens are not extensive, and hop growing is confined to a comparatively small area, while the so-called hop belt is a limited one. The total area under this cultivation amounts, according to the latest statistical returns, to about 26,000 acres, and this is divided into districts known under the names of the cities around which they centre. The largest and the best known is the Saatz district, with an area of about 10,000 acres. The neighbouring district of Rakonitz, with an area of about 600 acres, produces a grade of hops very similar in quality to that of the Saatz district; then come the Auscha district, with an area of about 4,000 acres, the product of which is not considered as good as the Saatz hops, and the Dauba district, with an area of some 2,500 acres, producing an inferior grade of hops. The most celebrated of these districts is the Saatz, and the hops grown there are claimed to be the best in the world. The hops of the Saatz district are again subdivided into *Stadt*, *Bezirks*, and *Kreis* classifications, according to quality, and the *Stadt*, or city hops, are the highest grade, while the *Kreis*, or circuit hops, are supposed to be somewhat inferior. In the Saatz and Rakonitz districts the hops are grown under similar conditions, and the products differ very little. The hops grow in a ferruginous, reddish clay soil, along the banks of the River Eger, while the region is protected from the cold north winds by a spur of the Erzgebirge, and the only prevailing winds are from the west and south-west. The elevation is about 800 feet above the sea level, and the mean temperature during the year about 7° Réaumur. The excellent qualities of the hops is ascribed to the peculiar properties of the soil, and to the very slight atmospheric depression. The hops of the Saatz, Rakonitz, and Auscha districts are all known under the general name of red hops, while the Dauba hops are called green hops. The distinguishing marks of the Saatz hops are a long flower, closed at the top with innumerable leaflets—from a hundred to a hundred and fifty—which are as soft as velvet to the touch. They are characterised by a delicate spicy aroma, and the bitterness is greatly appreciated. The flower, when ripe, is of a greenish yellow colour, with a slight reddish tint. Dauba hops, the type of green

hops, have a round flower with fewer leaflets—from forty to sixty—and the odour exhaled somewhat resembles garlic. The colour of the ripe flower is of a yellowish green. Red hops form three-fifths and green hops two-fifths of the total crop. Outside the regions above mentioned, the cultivation is carried on only on a small scale. The average crop in Bohemia is 9,000,000 lbs. in round numbers. The average yield per acre is not large, in the Saatz district it is between 350 and 450 lbs., while in the Auscha district, in a good season, there is a yield of 600 lbs. to the acre. The labour required for the cultivation is cheap, and hop-pickers receive about tenpence for a day's labour. With a view to securing a uniformly higher standard of hop culture there have been established, within the last two years, technical schools for the study of hop culture at Rakonitz and at Laun. These schools receive financial support from the Government of Bohemia, and also from the cities and districts where they are located. Being situated in the midst of the hop districts, every opportunity is afforded for practical work. In connection with the Rakonitz school there is an experimental hop garden, where innovations in cultivation are tried. The courses of instruction offered are both for students attending regularly, and for farmers desiring special instruction. Among the regular courses of instruction are hop culture, theoretical and practical from a botanical and practical standpoint, treatment of the soil, choice of the young plants, fastening of the poles, selection of the poles, hop picking, hop sorting, &c. The attendance at the schools has so far been considerable, and many students have come from other countries. The results have been so satisfactory that it is expected that hop culture will show a decided improvement as the schools become older and the students turn the knowledge acquired to practical use.

Notes on Books.

FOUR NATIONAL EXHIBITIONS.—By Charles Lowe. London: T. Fisher Unwin, 1892.

This book is intended as a record of the four Exhibitions which were held at Earl's-court in the years 1887-8-9-90, American, Italian, French, and German. The idea of holding in one country an Exhibition of the products of another was an original one, and that it should have been carried out with a reasonable amount of success for four successive years in London is a fact that certainly has to be noted in the history of Exhibitions. Mr. Lowe gives a very full, naturally a favourable account of the origin, rise, and progress of the scheme, a scheme quite worthy of record, and one reflecting a good deal of credit on the enterprise of those who conceived and carried it through.

General Notes.

DISCOVERY OF AMERICA.—A programme of the festivities to be held at Huelva during August and September next, in celebration of the fourth centenary of the discovery of America by Columbus, has been received from the Foreign-office through the Science and Art Department. The proceedings, which are to be of a very varied character, will commence on August 2nd, and will be continued until the 30th September. Among the entertainments which have been arranged for are regattas, sports, balls, banquets, &c.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 20 ... Geographical, University of London, Burlington gardens, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. J. J. Murphy, "The Reality of Knowledge."

TUESDAY, JUNE 21 ... Society of Architects, St. James's-hall, Piccadilly, W., 8 p.m. Annual General Meeting.

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. R. Walleschek, "An Ethnological Inquiry into the Basis of our Musical System." 2. Prof. Basil Hall Chamberlain, "Notes on some Minor Japanese Religious Practices."

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, JUNE 22...Geological, Burlington-house, W., 8 p.m. 1. Professor H. G. Seeley, "Contribution to a Knowledge of the Saurischia of Europe and Africa." 2. Professor H. G. Seeley, "Mesosauria from South Africa." 3. Professor H. G. Seeley, "On a new Reptile from Welte Vreden, *Eunotosaurus africanus*" (Seeley). 4. Mr. J. Postlethwaite, "The Dioritic Picrite of White Hause and Great Cockup." 5. Professor E. W. Claypole, "On the Structure of the American Pteraspidian, *Palæaspis* (Claypole), with Remarks on the Eamily." 6. Miss Maria M. Ogilvie, "Contributions to the Geology of the Wengen and St. Cassian Strata in South Tyrol." 7. Miss Jane Donald, "Notes on some new and little-known Species of Carboniferous *Murchisonia*." 8. Mr. J. S. Crawford, "Notes from a Geological Survey in Nicaragua." 9. Mr. F. Chapman, "Microzoa from the Phosphatic Chalk of Taplow." 10. Mr. Bernard Hobson, 'On the Basalts and Andesites of Devonshire, known as Felspathic Traps." 11. Mr. Thomas Tate, "Notes of Recent Borings for Salt and Coal in the Tees District."

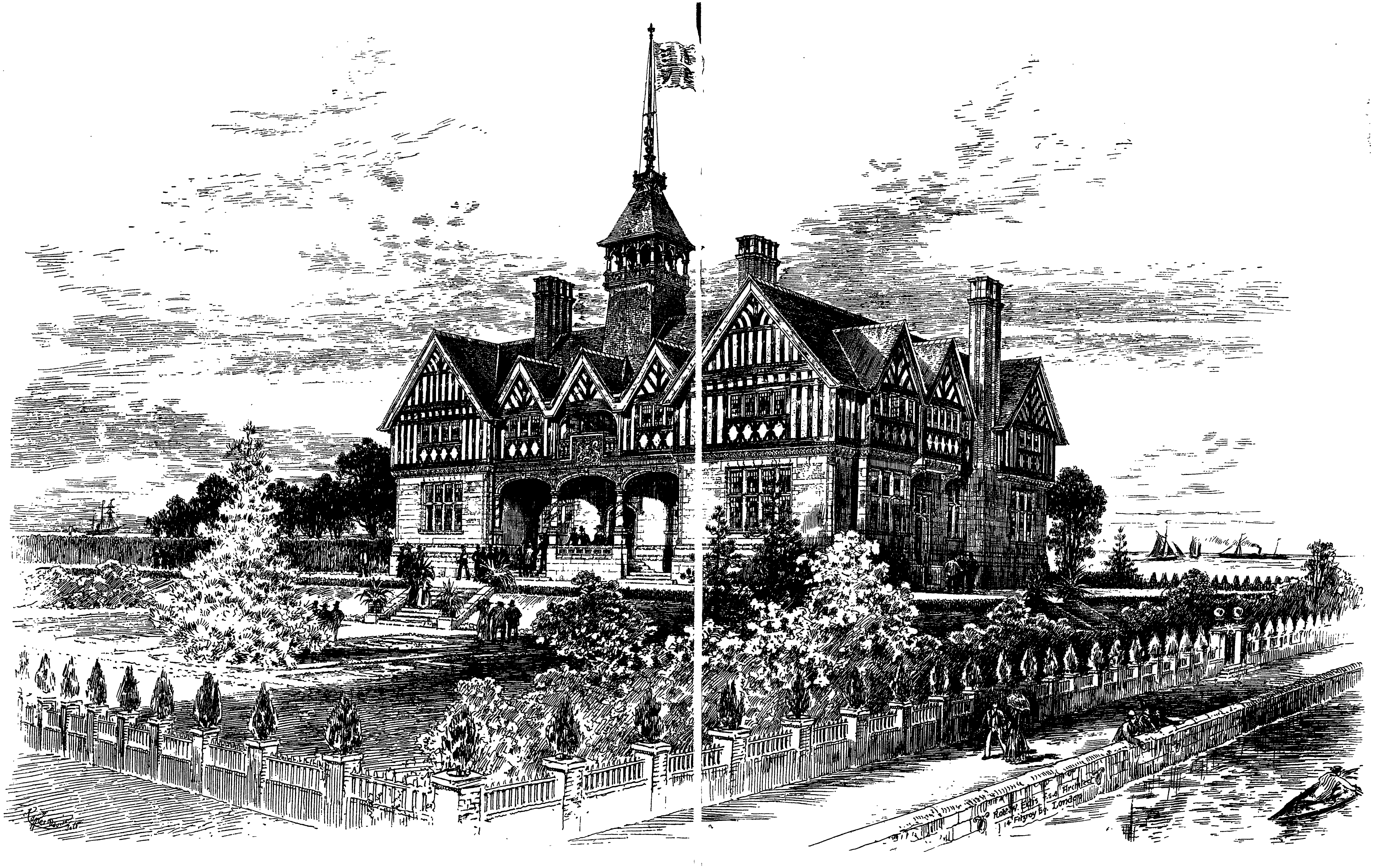
Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Floral *Fête*.

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

East India Association, Westminster Town-hall, S.W., 2½ p.m. Major-General A. Phelps, "The Increasing Mortality from Enteric Fever in the European Armies in India."

FRIDAY, JUNE 24...United Service Institution, Whitehall-yard, 3 p.m. Major G. F. R. Henderson, "The Recent French Manœuvres."

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. W. B. Croft, "Breath Figures." 2. Mr. E. Wythe Smith, "The Measurement of the Internal Resistance of Cells." 3. Mr. Williams, "Units of Measurement."



CHICAGO EXHIBITION: OFFICES OF THE BRITISH SECTION

Journal of the Society of Arts.

No. 2,066. Vol. XL.

FRIDAY, JUNE 24, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws :—

TREASURERS' STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1892.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1891	985	18	2			
Do. in hands of Secretary	18	4	11			
				1,005	3	1
,, Subscriptions	5,712	18	6			
,, Life Compositions	714	0	0			
				6,426	18	6
,, Dividends and Interest				726	10	5
,, Ground Rents				296	9	6
,, Examination Fees				561	5	0
,, Prize Fund Donations :—						
Clothworkers' Company				20	0	0
,, Advertisements				770	19	10
,, Sales, &c. :—						
Cantor Lectures	29	15	0			
Examination Papers	0	12	5			
Fees for use of meeting-room	32	11	0			
Journal	119	7	6			
Spoiled Post-cards	3	2	8			
Jury Reports (1862)	0	10	6			
				185	19	1
,, Bequest of £100 by the late John P. Stocker, Esq., less duty and law expenses				89	10	0
				£10,082	15	5

Cr.

	£	s.	d.	£	s.	d.
By House :—						
Rent, Rates, and Taxes	382	10	4			
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	263	17	5			
Repairs and Alterations	79	15	4			
				726	3	1
,, Office :—						
Salaries and Wages	2,173	10	3			
Stationery, Office Printing, and Lithography	309	9	3			
Advertising	85	11	9			
Postage Stamps, Messengers' Fares, and Parcels	220	2	6			
				2,788	13	9
,, Library, Bookbinding, &c.				86	2	7
,, Conversazione (1891)				392	4	0
,, *Journal*, including Printing and Publishing				2,225	11	10
,, Advertisements (Agents and Printing)				407	13	8
,, Examinations				555	2	6
,, Medals :—						
Albert (1890 and 1891)	43	14	9			
Society's	34	8	0			
				78	2	9
,, Drawing Society Prizes				8	6	6
,, Owen Jones Prizes				20	11	0
,, Cantor Lectures				212	6	10
,, Juvenile Lectures				30	0	0
,, Sections :—						
Applied Art	61	4	0			
Foreign and Colonial	41	4	0			
Indian	63	12	10			
				166	0	10
,, Committees (General Expenses)				13	19	6
,, Investments :—						
Consols (including Life Compositions £714, and Stocker Bequest £89 10s.)				1,378	0	0
				9,088	18	10
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1892	979	14	3			
Do. in hands of Secretary	14	2	4			
				993	16	7
				£10,082	15	5

LIABILITIES.

	£ s. d.	£ s. d.
To Accounts due	368 14 8	
,, Examiners' Fees	231 9 0	
,, Examination Prizes	68 0 0	
,, Do. Balance of Grants by City Companies	23 10 0	
,, Sections:—Applied Art, Foreign and Colonial, and Indian	190 0 0	
,, Accumulation under Trusts	489 16 0	
		1,371 9 8
Excess of Assets over Liabilities		17,771 5 8
		£19,142 15 4

ASSETS.

	£ s. d.	£ s. d.
By Society's Funds invested in—		
£10,653 0s. 10d. Consols, estimated at	10,000 0 0	
£500 Canada 4 per Cent. Stock, estimated at	515 0 0	
£500 South Australia 4 per Cent. Stock, estimated at	520 0 0	
£530 10s. 1d. New South Wales 3½ per Cent. Stock, estimated at	525 0 0	
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, estimated at	270 0	
£1,500 Queensland 4 per Cent. Bonds, estimated at	1,530 0 0	
£500 Natal 4 per Cent. Stock, estimated at	525 0 0	
Ground Rents	526 0 0	
		14,411 0 0
,, Subscriptions of the year uncollected	579 12 0	
,, Arrears, estimated as recoverable	190 0 0	
		769 12 0
,, Property of the Society, including Barry's Pictures and Lease of House		2,000 0 0
,, Advertisements on the Books, due and in course of execution*		568 6 9
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1892		979 14 3
,, Do. on Deposit (interest on Trusts)		400 0 0
,, Do. in hands of Secretary		14 2 4
		£19,142 15 4

* A portion of this sum is subject to charges for printing.

INVESTMENTS, &c., STANDING IN THE NAME OF THE SOCIETY.

	£ s. d.
Ground Rents	£7,690 0 0
Consols	12,257 1 1
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500 0 0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450 0 0
Canada 4 per Cent. Stock	923 0 0
South Australia 4 per Cent. Stock	605 16 0
New South Wales 3½ per Cent. Stock	530 10 1
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Queensland 4 per Cent. Bonds	1,500 0 0
Natal 4 per Cent. Stock	500 0 0
Cash on Deposit with Messrs. Coutts and Co.	400 0 0

TRUST FUNDS INCLUDED IN THE ABOVE.

		£ s. d.	
1.	Dr. Swiney's Bequest	£4,500 0 0	Invested in Ground-rents, and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100 0 0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiène Prize	133 6 8	,, ,, ,, Interest as a Money Prize.
4.	North London Exhibition Trust	192 2 2	,, ,, ,, ,, ,,
5.	Fothergill Trust	388 1 4	,, chargeable with the Award of a Medal.
6.	J. Murray, in aid of a Building Fund	54 18 0	,,
7.	Subscription to an Endowment Fund	562 2 2	,,
8.	Dr. Aldred's Bequest	173 10 0	,, chargeable with the Award of a Prize.
9.	Thomas Howard's Bequest	500 0 0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10.	Dr. Cantor's Bequest	4,600 0 0	Bombay and Baroda Railway Stock, and Ground-rents, Interest applied to the Cantor Lectures.
11.	Owen Jones Memorial Trust	423 0 0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12.	Mulready Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14.	Accumulated Interest on Trust Funds	400 0 0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and Securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

OWEN ROBERTS, }
B. FRANCIS COBB, } *Treasurers.*

HENRY TRUEMAN WOOD, *Secretary.*

J. O. CHADWICK AND SON, *Auditors.*

Society's House, Adelphi, 21st June, 1892.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Eighth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th June, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's *conversazione* will take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday, 29th June.

The reception by the Attorney-General (Sir Richard Webster, M.P.), Chairman, and the Members of the Council of the Society will be held from 9 to 10 p.m.

Promenade Concerts will be given by the Band of Royal Engineers in the North Court, and by the Band of the Scots Guards (weather permitting), in the Quadrangle of the Museum.

A Vocal and Instrumental Concert by the Meistersingers and Meistersingers' Orchestra will be given in the Lecture Theatre under the direction of Mr. Norfolk Megone. The first part of the concert will commence at 9.15.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual Refreshment Buffets in the Central Corridor of the Museum.

Programmes of the musical and other arrangements will be distributed on the evening.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. The conditions under which the use of the Museum has been granted by the Science and Art Department do not permit the sale of tickets; Members will therefore not be able to purchase additional tickets for their friends, as in recent years.

The cards have now been issued to the members.

MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1891-2:—

To Prof. SILVANUS P. THOMPSON, F.R.S., for his paper on "Measurement of Lenses."

To G. H. ROBERTSON, F.C.S., for his paper on "Secondary Batteries."

To Captain F. E. YOUNGHUSBAND, for his paper on "The Pamirs."

To Prof. VIVIAN B. LEWES, for his paper on "Spontaneous Ingnition of Coal, and its Prevention."

To ROBERT S. MCCORMICK, for his paper on "The Trade Relations of Great Britain and the United States."

To Captain W. DE W. ABNEY, C.B., F.R.S., for his paper on "Colour Blindness."

To F. E. IVES, for his paper on "Composite Heliochromy."

To F. A. PEZET, for his paper on "Peru: its Commerce and Resources."

To Sir EDWARD BRADDON, K.C.M.G., for his paper on "Australia: its Progress and Resources."

To G. H. M. BATTEN, for his paper on "The Opium Question."

To Dr. J. AUGUSTUS VOELCKER, for his paper on "The Agricultural Needs of India."

To JERVOISE ATHELSTANE BAINES, for his paper on "The Administration of the Imperial Census of 1891 in India."

To WILLIAM MORRIS, M.A., for his paper on "The Woodcuts of Gothic Books."

To C. PURDON CLARKE, C.I.E., for his paper on "English Brocades and Figured Silks."

To WILLIAM DE MORGAN, for his paper on "Lustre Ware."

Thanks were voted to the following Member of Council:—

To JAMES DREDGE, for his paper on "The Columbian Exposition at Chicago, 1893."

Chicago Exhibition, 1893.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee of the Royal Commission was held on Wednesday, 22nd inst. Present: The Attorney-General, M.P., Q C., in the chair; Sir Frederick Abel, K.C.B., F.R.S., Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., Francis Cobb, James Dredge, George Matthey, F.R.S., Sir Owen Roberts, M.A., D.C.L.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 31, 1892; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., in the chair:—

The paper read was—

LUSTRE WARE.

BY WILLIAM DE MORGAN.

The word "lustre," in its connection with pottery, has not always been used in its present limited sense, but rather as an equivalent of our word "glaze." It has been applied to the glossy surfaces of the Greek, Roman, and Etruscan pottery,* although the gloss upon these is comparatively slight. Nevertheless they are lustrous as compared with unglazed tile or brick. In a more restricted sense the term may describe any metallic deposit on a glazed surface where the decorative effect depends upon, or is enhanced by, reflected light. But even this definition would be now-a-days disallowed by the common understanding of the word, which applies it almost invariably to the special iridescence of the Persian, Arabian, Hispano-Moresque, and Italian majolica. This iridescence, the means by which it has been and is obtained, and more especially the means by which I have myself endeavoured to obtain it, form the subject of the following paper. It is a subject which may be treated either historically or technically, but the two lines of treatment intersect at many points, and it is at these points, if at any, that what I have to say may be of interest. I will, therefore, before describing my own experience, give the shortest possible retrospect of the history of the subject, although in so doing I shall no doubt be going over ground already familiar to many now present.

All investigations seem to converge towards the conclusion that Egypt or Assyria were the earliest nurseries of the art of decorating pottery, which afterwards attained its maturity in Persia. The glazed and coloured terra-cottas from the palace of Darius, brought from Susa by M. Dieulafoy,† and now in the Louvre, show that those who produced them possessed all the materials and almost all the processes known to their successors. But there is no apparent knowledge of the lustre process either in these or any other ceramic productions of remote antiquity, although an accidental stain of copper lustre has been detected on an Egyptian vase in the British Museum. The earliest lustres known are those found on fragments dug from the ruins of Persian cities, more especially those of the city of Rhé, or Rhages, to which a very great antiquity has been assigned. They have been generally accepted as antedating the destruction of the city 600 years ago.* But although Sir R. Murdoch Smith speaks of a possible age of 2,000 years for some of them, this is very conjectural; and until we can find proof of the process being in existence in Persia previous to the Arab conquest in 641, its Persian origin cannot be considered beyond a doubt. However ready we may be to ascribe a Persian parentage to the art of the Arabs,† we cannot shut our eyes to the fact that the area of Arab conquest in the 9th century is almost exactly co-extensive with the distribution of the manufacture of lustres, so far as it is known to us, in the 12th. Before the Arab conquest, decorated Persian ware is known to have existed by surviving samples, all without lustre. As soon as our authentic record of lustre-making begins, it is found throughout the conquests of the Arabs, and nowhere else. In 1154, Edrisi, the Arabian geographer, speaks of it as being then made at Calatayud, in Spain, which was at that date a recent conquest of the kings of Arragon from the

* The gloss on these was a matter of preference, not due to inability to produce ordinary glazes. Deck mentions moulds for pastry, glazed inside, in the museum at Naples, as proof of this.

† These are enamelled with a white tin glaze, according to Deck.

* Possibly, but not necessarily. All depends on the locality and nature of the excavation. An instance, cited by Mr. Henry Wallis, of a fragment found at Brahminabad, and now in the British Museum, does not appear of so old a date as the destruction of that city in the 11th century. It is a piece of silver lustre, probably Persian.

† We may be tempted to the belief that the Arabs got it from the Persians by the splendour of the Sassanian civilisation, but we should distinguish between the knowledge of a traditional process and the capacity for making use of it. Besides, although the Arabs have been called savages at the time of the conquest of Persia, they were the savages who, a century later, were building the mosque at Cordova. Nobody suggests that they learned anything from the Visigoths. Sir R. Murdoch Smith surmises that the Alhambra was really the work of Persians. It is possible, but is not the surmise more the result of a conviction that the Arabs could not have done it, than a result of actual record, traditional or otherwise? There is one Persian lustred tile at South Kensington Museum said to be 1,300 years old (No. 1841. 76). Sir R. M. Smith judges it pre-Mahommedan, because the later artists never represented human figures. It certainly is an exception either to this or the universal absence of pre-Mahommedan lustre. But in the absence of more examples, one exception is as likely as the other.

Saracens. A century before (1040), Nassiri Khosrau testifies that they were made at Cairo. These are, I believe, the two earliest trustworthy testimonies to the manufacture of lustred pottery.

Perhaps the safest judgment as to the origin of the process in modern times is that which makes the Arabs the distributors, east and west, of a knowledge transmitted to them from Egypt or Assyria. It is stopped in its journey eastward at the borders of the Persian empire, and is conspicuously absent from China and Japan. Its non-appearance in the manufactures of these countries may be accounted for by the nature of the materials already in use. I have tried to get lustres on Chinese and Japanese ware, but have always failed; the glazes appear singularly refractory. Other causes may have helped to prevent the Persian or Arabic process going eastward. In the other direction, the course of the Arabs, from Cairo to Tangier, has been said to be traceable by the glazed and decorated wall tilings of their buildings, especially the mosques. No doubt this is in some sense true, but it has been more than once told so as to convey a false impression that the Saracen invaders of Africa built tile-kilns at every station of importance, and that pottery factories were at work in Spain, if not during the time of the Abbasides, at any rate very soon after the establishment of the Caliphate of Cordova. Wall tiles, beautifully decorated, were placed by the historical imagination on the walls of the great mosque at that town, and by implication at Seville and Toledo also. But the tendency of more recent investigation is to ascribe all the surviving examples of Arab wall tiling in Spain to a much later date. However, there might have been wall tiles in the mosque of Abd-el-Rhaman of native manufacture, as fragments of decorated pottery, supposed by some to have been made in Spain about the year 969 A.D., occur in the Museum at Grenada. The construction of the mosque was still going on in the time of the vizier Almansor, who melted up the bells from the shrine of Compostella to make lamps for the mosque, at which he used to work with his own hands. This was in 985. But, if we judge by contemporary descriptions of buildings, these great mosques, and others, such as the palaces of Az-zahra, at Cordova, were marvels of decoration in marble, gold, and ivory, but were entirely without wall tiling. Moreover, mosques of the same period, at Cairo and elsewhere, are entirely without tile decoration.

The next landmark in the history of the subject is the erection of the Alhambra by the Moorish kings of Granada. The old tiles with which its walls are covered are genuine native *azulejos** of the date of the completion of the building, about 1350. They must be distinguished from those placed in the building when it was restored by Charles V. in the 16th century. They belong to the same group of manufactures as the great jars which were found full of coin under the building. The well-known one, of which there is a copy by Deck at South Kensington, is still in the Alhambra, and there is a similar one in the museum at Madrid. These and one or two others are the oldest surviving examples of the practice of lustre in Spain. There does not seem to be any need to assume that they were imported from Cairo or Persia, and we may probably ascribe their fabrication to Malaga. The Alhambra tiles may have been made there too, although in view of the comparatively simple operations involved in the making and firing of the latter, and the vast quantity required, it might be more reasonable to suppose they were made on the spot. It would have been far easier to build a kiln on the works at Granada than to carry all that weight of tiles over the Sierra Tejada. But the pots were quite another thing. They were made for exportation as well as native consumption, and Ibn-Batoutah, an Arab traveller, found the manufacture in full work at Malaga in 1350.

Time, or rather the want of it, prevents my making more than a passing allusion to the

* This word *azulejos* is, I believe, considered to have no connection with *azul*, blue, and is said to be derived from an Arabic word of similar sound. Although the researches of an ignoramus in dictionaries of languages he is unacquainted with have no value, perhaps I may mention one or two perplexing points in this derivation. If I understand Senor Juan Riano ("Industrial Arts in Spain," p. 167), the first mention of the word occurs after 1400. But a different word for tiles is used in King James of Arragon's charter to the potteries of Xativa, namely, *rajolas*. *Rajar* in Spanish means to split or divide into chips, and no one who has ever sliced tiles out of slabs of clay will wonder much at their being called slicings or splittings. It certainly suggests that the word *azulejos*, which also is a distinctly Spanish name for the cornflower, belongs to the Spanish period. If the Arabic word means nothing but tiles, why should it not be a derivative of the Spanish word? Of course I am supposing (from the uncertain way in which my informants write) that it is not a familiar Arabic word, or very ancient. It would be odd if historians accepted as probable the theory that the Arabs conquered Persia and carried Persian art half over Europe, and rejected the possibility of their having carried a word away from the language of Spain after centuries of occupation. My dictionary calls *azulejos* blue Dutch tiles. It is a curious fact in this connection that in the East the important tile *par excellence* is a piece of blue placed over the door of a house to keep away the *Afreets*.

lustred wares of Sicily. There are some examples of what has been called Siculo-Arabian ware to distinguish it from the dark blue pottery covered with small diaper ornament, which is ascribed to Saracenic or Moorish potteries at Calata-girone (about thirty miles from Syracuse), probably of the period of the maturity of the Hispano-Moresque. I believe there is nothing antedating the Norman Conquest of Sicily. But there is documentary proof of the exportation of *faïence* to Sicily from Barcelona, in 1528, which suggests that the manufacture never became firmly rooted. However, we must remember that Sicily had been under the Spanish rule, or misrule, from 1479, and hunting Saracens was a part of their political economy. The desirability of extending the export trade may have accelerated the suppression of the Siculo-Arabs.* I am rather surprised that the near coincidence of this date of the Spanish in Sicily with the appearance of lustres in Italy should not have caused the ascription of its Italian origin to these particular potters and no others. It would have been at least as plausible as the other theories.

One of these had its origin from the existence of *bacini*, or *bacili*, with which the walls of certain churches at Pisa and elsewhere are decorated. Marryat, the historian of pottery, ascribed a Saracenic character to these, and framed a theory to account for them which is so picturesque that I wish it were true.

In 1115, the Pisans made a crusade against Nazaredek, the Saracen King of Majorca, whom they overcame after many mishaps by land and sea. They liberated no less than 30,000 Christian captives from his dungeons, and returned home with shiploads of Saracen prisoners, gold and silver, embroidered garments, and decorated crockery, to say nothing of two large porphyry columns, which they afterwards gave to their allies, the Florentines, and which stand on each side of Benvenuto Cellini's Baptistry gates to this day—an eternal testimony to the truth of the story. The decorated bacini in the walls of the churches at Pisa were supposed to have been placed there as trophies, and, indeed, continued to be thought so until Mr. Fortnum's examination of them in 1868 settled the matter. He made a close inspection of those on six churches at Pisa, and found only one fragment of Saracenic origin. Marryat had the tale of the crusade—which, no doubt, is good history—from Sismondi, but Sismondi says nothing whatever about the cargo of lustred pots. His chief authority is Laurence of Verona, who wrote a poem about the Crusade. It does not seem to contain any allusion to the *bacini* or kindred subjects, but then my failure to find it in 3,000 Latin hexameters is far from conclusive. However, what I rely on is that I have seen no citation from them in Mr. Fortnum's writings. Mr. Fortnum has been over the ground, and had there been a word about the *bacini* in the poem, he would certainly have found it out. The passage in Marryat's history conveys the impression that he did not look behind Sismondi, and indeed that his conjecture was a mere passing surmise, chiefly based on the *bacini* in the church walls themselves.

Another conjecture, which would have been just as good as the foregoing if the dishes had been Oriental in character, ascribes their origin to the Saracen merchant ships captured by the Pisans at Syracuse or Palermo, at the time of their alliance with the Normans in their invasion of Sicily in the 10th century.

Another, the latest I have met with, is that of M. Mely, who tells us that at Tchakindji in the Caucasus, the armorial bearings of Genoa and Pisa occur on mediæval buildings, and that the mosque of Erivan in that neighbourhood is richly decorated with tiles. He suggests that this may have been the point of contact between West and East which caused Italian pottery. But there is no difficulty in finding ways in which the Italians *might have* learned technical secrets from the Saracens. The difficulty is to connect the actual art, as it appeared first in Italy, with any one of the sources to which it has been ascribed.

Majorca has certainly had the preference hitherto. But we have no actual record till

* The Saracen foothold in Sicily dates from 830, and had a certain amount of life in it till about 1072. The period of the Spanish viceroys began in 1479, under Ferdinand of Spain, but was preceded by the house of Arragon (1282). It is true that Jaymé I. of Arragon, in 1239, figures as a benefactor to Saracen potters at Xativa San Felipe, near Valencia. He extended his royal protection to them in return for a small tax. That was his account of the matter. Probably *they* would have said that he charged them one bezant per annum per furnace for leaving them alone. This would be a Moorish gold bezant (called marabotini, or maurobotini), such as occurs frequently (Py. Cycl. article, Bezant) in Arragonese charters. Ferdinand was called the Catholic, having shown his catholicity by persecuting the Moors before their final proscription, and founding the Inquisition; also by refusing to allow Papal Bulls to become valid without the consent of a secular council. The remains of the Siculo-Arabs must have found existence irksome in Sicily from 1479 onwards, and the ruby lustre appears just after this time on the class of dishes ascribed by some to Pesaro, by others to Gubbio.

1442,* when one Giovanni di Bernardi, of Uzzano, in a treatise on navigation, speaks of "the ware of Majorca and Minorca, which had then a very large sale in Italy." To my own thinking, there are two things which account for the prominence given to Majorca. One is the story of King Nazaredek and the conjecture Marryat founded on it about the bacini. The other is the name majolica, applied to lustred ware at first, and afterwards to all Italian *faïence*. But when we come to look for the first use of the word in the sense of pottery, we are referred to Julius Cæsar Scaliger in the 16th century, who says that the recent skill of the Majorca potters has made such clever imitations of Indian (Chinese) pottery, that it is hard to tell them apart, and that these are called after Majorca, all but a letter or so. An antiquity which this record is not entitled to creeps round it in the mind of any unobservant reader when, in close proximity, he reads the line of Dante, in which he speaks of "l'isola di Cipri ê *maiolica*." I feel certain that many who have seen this connection of two writers born over 200 years apart, must have run away with the idea that Dante called earthenware majolica.

There is also the testimony to the importation of Spanish-Moorish ware from Valencia to Italy of Escolano, a Spanish writer, who says that Pisa was the port to which the Moors exported their *faïence*, in exchange for that of Italy. This is a very odd statement. If the merchants of that date (before 1600) really brought *faïence* back from Italy, it must have been something of great value, some article of luxury. It is utterly inconceivable that they should bring back freights of cheap serviceable earthenware to a country famous for its crockery since the days of the Romans, when Murviedro was Saguntum. On the other hand, if rare and highly decorated work came from Italy, where is it now? It is well known that the bulk of the fine samples of Hispano-Moresque were found in Italy, having been exported to the Italians as a favourite article. There should have been a few, at least, of corresponding samples in Spain of imported Italian ware.* However, it is noticeable that testimony of Spanish exports to Italy at an early date should also bear witness to the importation to Spain of Italian ware presumably of equal value. It is also a fact of much importance that, while all this testimony is limited to showing that there was a commercial reciprocity between the Spanish ports and Pisa, the first records of lustred pottery in the north of Italy begin, not at Pisa, but at Pesaro.

Pesaro is a clay centre, and a seat of pottery manufacture from a remote antiquity. Passeri, the earliest historian of Majolica, was Vicar-general of Pesaro, and although he writes with some natural partiality for the town, I believe his conclusions are generally respected, especially as he had opportunities for inquiring into the earlier manufacture which no longer exist. He places the decoration of the mezza-majolica (as the ware came to be called) as early as the end of the trecento period, and the characteristic madreperla lustre towards the end of the quattrocento. He also claims for Pesaro the honour of having produced ruby lustre in 1480. If some of the mezza-majolica at the British Museum is rightly dated, there is no reason why this should not have been the case. At any rate, Pesaro is where we have to look for the Moors, who came and taught the Italians lustre.

Now, Pesaro is a long way from Pisa, and the Apennines are between. It is quite as near Venice, and is a seaport. For every one communication between Pesaro and Pisa in the Middle Ages, there would be a hundred between Pesaro and Venice. And between Venice and Syracuse there would be much more frequent communication than between Valencia and Pisa. If we must have Arabs to teach the Pesarese lustres, why not go to Sicily for them. The fact is, that a mistaken historical clue guided the inquirer to Pisa first, in the case of the 12th century bacini, and it is difficult to get away from it. If another instance of bacini—that of the church of

* I have never seen any notice of the appearance of this ware in pictures of the date. Ugo Vander Goes, the Flemish painter, whom Maso Portinari commissioned to paint the great "Nativity" in the hospital of St. Maria Nuova, at Florence, has placed in the foreground of that picture, an unmistakeable Hispano-Moresque albarello, or drug-pot, with a blue and silver lustre pattern. I do not know if the date of the painting of the pot can be established, but the picture was painted in Italy about 1480. This may be safely inferred (if it is not otherwise known, which, perhaps, may be the case) from the date on the Ghirlandaio Nativity in the Academia. In this the shepherds are clearly painted from the same models, and the influence of the Flemish painter is, perhaps, visible elsewhere. Ghirlandaio was then four-and-twenty, and open to influences; his picture is dated 1485. The relative scarcity of Hispano-Moresque ware in the North is illustrated by the absence, generally, of such pots from Flemish and German pictures. I have never, myself, seen any but this one.

* A dish in the Henderson collection, with Marcus Regulus painted on the face, has a Spanish inscription on the back. Was it an Italian artist's in Spain, or an order sent to Italy by a Spaniard?

Lucera, in Apulia—had attracted attention to the same extent, we probably should now find it equally difficult to get rid of the Moors or Arabs of Calata-girone. For my own part, I do not believe either had anything to do with it, beyond the impulse the circulation of their ware gave to the ingenuity of one of the cleverest races in the world in an age of increasing artistic activity.

I have lately had the satisfaction of finding that this opinion is also expressed in the work of M. Theodore Deck on "Ceramics." M. Deck's opinion ought to have great weight, as he is certainly the most eminent practical potter who has written on the history of the subject.

I have dwelt upon this historical evidence, because it is just one of the points at which the lines of history and technical inquiry intersect. I will now give my version of the other side of the matter.

The technical distinctive feature of Hispano-Moresque ware is that it is invariably on a white ground of glaze rendered opaque by oxide of tin. All the mezza-majolica, the early Pesarese ware, is on the white ground described by Passeri, which had, according to him, been in use since 1300, perhaps earlier. It is not a tin enamel, but a white slip covered with a mixed glaze of lead and alkali, *marzacotto*. Not a single dated example of lustre appears in Italy on a tin enamel till near the end of the 15th century, either at Pesaro or elsewhere. Now I can testify, and so can every potter who has ever made lustre, to the facility and certainty with which it can be produced when tin is present in the glaze as compared with other glazes.

That the Italian potters should learn from a Moorish source, and yet get so little clue to the superiority of this white ground that no experiment in its use should survive, and no tradition be handed down, is most improbable. But it becomes more improbable still at the next step in the history of majolica when, about 1475, or perhaps rather earlier, the tin glaze begins to supersede the white slip. The course the Italian potters took then was to use it not as the glaze *par excellence* susceptible to lustre, but as a whiter substitute for the white slip, glazing it over with marzacotto precisely as they had glazed the old ground. It might be difficult to pronounce certainly on this point from inspection alone, but there is other testimony. Piccolpasso, in his very explicit description of the Gubbio process and Italian pottery generally, in 1548, leaves no room for doubt. He notices the necessity for glazing the tin glaze thinner than the white *terra di Vicenza*, or slip. But there is not the slightest hint that the old marzacotto glaze was ever discarded.

It may be objected that the tin glaze was unknown, or unobtainable. There is strong evidence to the contrary even as to its use by Italian potters, and the tendency of recent research is to place the date of its adoption earlier and earlier.* But apart from this, it was in use in Italy for another purpose long before. Luca della Robbia† had had time to mature his method of covering terra-cotta with it, and to place his two great bas-reliefs above the doors in the Duomo at Florence by the year 1438. So that, however much we strain dates, there is a long period during which the tin enamel was known in Italy, and yet the makers of the mezza-majolica persisted in the use of a ground of their own, while, had they been acting under Moorish instructions, they must certainly have been looking and longing for the more manageable Moorish ground. If Luca got his knowledge (as Jacquemart supposed) from the potteries of Faenza or Caffaggiolo, it makes the combination of circumstances still more puzzling. Faenza is a two days' journey (about 70 miles) for a horseman from Pesaro, certainly not more —and the interchange of *employés* was probably not uncommon.

I believe what I have said would hold good equally whatever view is taken of the exact date of the first Pesarese lustres. The question is a little complicated by the fact that the date of the lustre is not of necessity that of the piece. An unlustred piece of *faïence*, 300 years old, could be put through the kiln now, and no human penetration could discover the date of the lustre. Bacili made at Pesaro in 1450 may have been lustred at Gubbio in 1550.

* See Fortnum's reply to Prof. Argnani, *Academy*, Sept. 6, 1890, No. 957. Dr. Umberto Rossi and Prof. Milanesi date the use of tin glaze in Tuscany as early as 1300–1400.

† The tiles on the tomb of Benozzo Federighi (1456), which appear to be on tin, are among Luca's works. In these, the technical point most prominent is that Luca wanted something golden, or something akin to lustre, and could only get it by cutting out the background in mosaics of a rough sort of pottery gilding. But if he had had his white ground from a Saracen potter, he would probably have lustred the background, even if danger to his other pigments had compelled him to use separate pieces. But there is a disposition to refer to Faenza and Caffaggiolo as Luca's sources of information about tin; and if a small oil-jug in the Henderson collection is rightly ascribable to either, they could make lustre there also.

I leave this part of the subject with many things unsaid, in order that I may not be forced to omit the next landmark in the history. The bottega at Gubbio, and its connection with Giorgio Andreoli, has been considered as the most important of all from an artist's point of view. Maestro Giorgio was a sculptor, a pupil of Luca Della Robbia, who took to pottery and worked at this bottega, which had already produced some fine lustre work, perhaps as fine in all decorative respects as any which followed. The free use of ruby distinguishes this from the mezza-majolica, and the Maestro Giorgio productions may be again distinguished from it by a varied character in the ruby, and a finer white ground. The aim evidently is a transparent ruby to be used as a pigment. To my own thinking, the work throws doubt on its suitability for this purpose. However, there can be none that in his time the colour attained its greatest brilliancy. The dates range from 1518 to 1537, the later examples being by his son and other contemporaries, who carried on the work a little longer. But all lustres disappear from Italian decorative work about 1550, so that a period of 60 years covers the whole production. I have before spoken of the longer lifetime of the Hispano-Moresque process, but, in both cases, the disappearance was only that it ceased to be used on elaborate work; as certainly in Spain, and possibly in Italy, the practice has never completely died out.

It is more difficult to account for its disappearance so long before the collapse of the arts in the 18th century than for the vigorous and successful attempts to out-do the Moorish pottery in the age of Renaissance. It may satisfy some to say that a change of fashion did it; but this is only substituting one phrase for another, and very nearly means nothing at all. A plausible surmise is that its use became incompatible with the careful and dexterous brushwork on fresh-dipped enamel, which reached to such perfection at Castel Durante and Urbino. The greater an artist's success in manipulation, the less is he disposed to incur the risks of an uncertain firing. A lustre-kiln may spoil the whole outright, or even if the lustres themselves are successful, may only come into existence at the cost of elbowing their neighbours out of it. So long as the material was used for its own sake, and no attempt was made to go beyond its natural limits, all went well, but as soon as the artists began to be discontented with the restrictions its use put upon their opportunities of showing their own dexterity, the lustre colour had to give way. It may have been this, or possibly the demand may have been diminished by the disappointment consequent on local mishaps. The death of a furnaceman of special skill might cause a suspension of work, or, what is more likely, a substitute might be found whose failures might lead to a belief that the process depended on some secret which his predecessor had kept to himself. Whatever the cause, or complication of causes, they vanish in 1550, and do not re-appear for 300 years.

The process is not described by Brongniart, who was the great technical authority on pottery of fifty years ago; and Salvêtat, who was his successor, makes only a very speculative allusion to its possible character. And in the catalogue of the Great Exhibition of 1851, which is a sort of death register of the arts of antiquity, not a hint of lustred pottery appears. The modern revivals begin with those at the Ginori factory at Doccia, near Florence, and those of Carocci at Gubbio,* of which Mr. Fortnum speaks very highly. There were some of these in the 1862 Exhibition in London. I have never seen any myself. The best I have seen are those of Cantagalli, at Florence.

In spite of the Doccia and Gubbio reproductions, an impression continued to prevail that the process was a secret. I used to hear it talked about among artists, about twenty-five years ago, as a sort of potters' philosopher's stone. At that date the attempts to reproduce it in England had met with only very partial success, although an Italian had gone the round of the Staffordshire potteries showing how to do it. Even now it is sometimes spoken of as a secret by newspaper writers. My attention was attracted to some very interesting work of Massier, of Cannes, in the last Paris Exhibition, by a newspaper paragraph headed "Re-discovery of a Lost Art."

In fact, re-discovery appears to have dogged the footsteps of the lustres from the beginning. I re-discovered them myself in 1874, or thereabouts, and in the course of time some of my *employés* left me, and re-discovered them again somewhere else. I do not think any re-discoveries of this sort contributed in any way to the very general diffusion of the process in

* A story is told by Marchese Brancaleone of the re-discovery at Gubbio, that an old painted unfired piece, of the Giorgio time, was found in what was supposed to be his old kiln-house. One of these fell into a scaldino, and remained in contact with the fuel. Next day it was found that a lustre had developed on it. (Brancaleone Letter to Marchese Eroli, 1857, p. 24.)

the potteries at this moment. Very likely some of them have an earlier record than mine, but the only one I chanced upon when I was in Staffordshire was that of the late Mr. Clement Wedgwood, who showed me a number of experiments which would have been successes if the glaze had been suitable, and a small sample shown me by the late Mr. Colin Campbell. As far as the technical difficulties of simply evolving a copper or silver lustre go, I see no reason why (as in the case of the Arabs and Italians) every discovery should not be totally unconnected with every other. But there was one thing the Italians found out, when they reproduced the Moorish firings, namely, how to make a strong, and beautiful, and original use of their materials. It may be that the less we say about the modern parallels of their case the better.

Perhaps we may now make a new departure, and consider that the process is as well known as any other process in the arts; at any rate, I will contribute what I can to make it so, by telling all I know of it myself. I got nothing from Piccolpasso, as I did not see the work till long after, nor from any printed information, except the chemical manuals I had read in youth. The clue was furnished by the yellow stain of silver on glass. When overfired this shows iridescence, which is often visible on the opaque yellow visible from the outside on stained glass windows. I tried the stain on Dutch tiles, and found them unsusceptible in the glass kiln, but, in a small gas muffle, I found that both copper and silver gave a lustre when the gas was damped down so as to penetrate the muffle. I pursued my investigation, and, after an interruption, occasioned by setting the house on fire and burning the roof off, I developed the process in Chelsea. This was 1873-74, since which time it has not varied materially, although I have tried many experiments, with a view to improving it.

As we now practise it at Fulham, it is as follows:—The pigment consists simply of white clay, mixed with copper scale or oxide of silver, in proportions varying according to the strength of colour we desire to get. It is painted on the already fused glaze with water, and enough gum arabic to harden it for handling and make it work easily—a little lamp black, or other colouring matter, makes it pleasanter to work with. I have tried many additions to this pigment, of infusible white earths such as lime, baryta, or strontia, and other metallic oxides, but without superseding the first simple mixture. Any infusible clay will answer the purpose, though we have always used kaolin, as the least fusible. In Deck's work on pottery he gives several receipts for lustre pigments, only one of which seems to me to belong to the true process of lustre. The others all contain sulphur, which is not necessary, though it may work very well. The sulphur lustres are akin to the old Swansea lustre, which only requires to be burnt at a low heat without smoke. The sulphur evaporates and leaves a metallic deposit which is not oxidated, or only partly so, by the access of air after the sulphur vapour has left the kiln. I believe all the lustres included in the colourmaker's lists are of this nature, but the results produced in modern ware do not tempt the investigator. The prettiest one I have seen is Burgos lustre, which, however, contains gold.* The only ingredient containing sulphur mentioned by Piccolpasso would be the small quantity of vermilion (that is, if *cinabrio* means vermilion), which he adds to his receipt for *oro*. Piccolpasso's recipes are for the diluent clay only, as he says nothing of either copper or silver. But he had them from hearsay, and if he really tried to produce lustre with them without any addition of metal, it quite accounts for no lustres ever appearing at Castel-Durante, where he was master potter. Indeed, it raises the question whether he was not hoaxed by Maestro Cencio, Giorgio's son, who is supposed to have given the information.†

The ware, when painted, is packed in a close muffle, which is then raised to a very low red heat, so low, when the ordinary tin enamels are employed, as to be only just visible. A charge of dry wood, sawdust, wood-chips, or, indeed, any combustible free from sulphur, is then introduced into the

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* Sir R. M. Smith says the Persian glazes contain gold, but he does not give his example of a chemical analysis showing gold.

† Senor Juan De Riano gives the recipes sent to Count Florida Bianca in 1785 from Manises. The pigment contains sulphur, and no mention is made of the reduction process. This rather inclines me to believe that the potters of that date, having found that a quasi-lustre could be obtained with the sulphur material, had either neglected the reduction by smoke, or only practised it in a modified form. If we accept this recipe as a true account of the Hispano-Moresque operation, it gives an additional reason for supposing that of Piccolpasso to be an independent re-discovery. The Italian process would consist of variations throughout. Signor Cantagalli has shown me the whole process as now practised at his works, and I have no doubt it is in all respects the same as the old Italian one. Certainly his results are more like the Pesaro and Gubbio than the modern Valencia ware is like the best Hispano-Moresque.

muffle through an opening level with the floor, a space having been left clear under the ware for its reception. As soon as it has blazed well up, the opening is closed. The flare then chokes down and the combustion of the charge is retarded, the atmosphere in the muffle consisting entirely of reducing smoke. The test pieces will soon begin to show a red or yellow stain, the pigment itself looking black, until it is wiped off to show the stain. This operation must be repeated until the tests look right, when the fires should be drawn and the muffle left to cool.

The difference between this operation and Piccolpasso's is chiefly in the use of the closed muffle, which is rendered necessary by the difference in fuel. The sulphur from coal or coke would injure the glazes where there was no lustre, and would interfere with the process itself. In the Italian process, where wood is the fuel, the wood is packed in a perforated sagger, into which the smoke from the furnace is choked back by closing a damper, or by simply increasing the volume of smoke from the furnace by heaping on brushwood. But the principle of the operation is the same in both cases, and the dangers are the same. The firing may be vitiated in either by any of the following causes. There may be too great heat, or too prolonged heat; the smoke may be too dense, or too attenuated, or not long enough maintained, or the reverse. If more than one of these factors is wrong at the same time, the harm done will be in proportion. Even when the conditions are most closely observed, the results will show unexpected variations. It is impossible to secure uniformity throughout a muffle. Consequently, the size of the ware must be small in proportion to that of the muffle, or a vase might be overdone at the top and underdone at the bottom, while a number of small pots in the same space would have turned out very well, a few of the top ones being uniformly overdone (and perhaps little injured), and a few of the bottom ones underdone, and only wanting a second similar firing. This also makes a longer and slower firing necessary with larger ware, and this means more risk.

The different sorts of copper lustre may be classified thus:—

1. Opaque metallic copper deposited on the surface of the glaze. The oxide is in this case probably reduced at the moment of deposit. Nearly the same result takes place in the common lustre of the potteries, where the sulphur of the sulphide of copper is driven off by a low heat.

2. Combination of copper suboxide with the glaze without reduction to metal. This is to all intents and purposes the same thing as when glass containing copper is flashed and becomes ruby. The harder the glaze is, and the higher the temperature, the less likely is a deposit of metallic copper.

3. The result of prolonging heat without smoke on No. 1. The deposited copper is thus slowly absorbed into the glaze, becoming ultimately red without lustre, but passing through every intermediate stage.

4. The result of increasing the reducing agent on No. 2. In this case the oxide already in combination is brought back to the state of metal. I believe that all the best lustre should be classed with this or No. 3.

Silver lustres show the same results, but at a lower temperature. So when both lustres are fired together, we may expect Nos. 3 and 4 of silver lustre, with Nos. 1 and 2 of copper.

The ugliest results are when the glazes are overcharged to the point of opacity. But accidents of this sort may be taken advantage of when the designer foresees the result. For instance, great blotches of opaque pale yellow on an inky black background may be very ugly, when an arabesque of fine lines of the same yellow on the same ground might be rather pretty.

I have said that the tin glaze is the most susceptible to lustre, but it does not necessarily give the finest results. The Gubbio lustres are really on superposed marzacotto, and possibly the exceptional beauty of some Persian lustre may be due to what is often called a siliceous glaze, which is what I call an alkaline glaze, as all glazes are siliceous. A film of such a glaze over the tin would almost elude any possible means of detecting it, and yet would scarcely be penetrated by the lustre colour, so thin is it.

The best of the first lustres I made on Staffordshire ware were on ironstone or granite. The body was repellent in colour, but the glaze particularly good. Latterly, we have used the common opaque white made with tin. It has also been ugly in colour, being, I believe, made so by the addition of cobalt, to make it whiter, just as the house-painter spoils his beautiful white chalk with French blue. I have tried many experiments with glazes, but I am inclined to think that the way they are fired in the glost oven has as much to do with

their adaptability for lustre as their chemical composition.

I have also tried in this past 20 years a vast number of experiments, with the idea of adding to the first simple process of the Arabs. To save others needless work, I will enumerate a few, with my recollection of their results.

1. Reduction by other agents than carbonaceous smoke: by ammonia, by steam in contact with reducing fuel, by coal-gas, by vapour of water and glycerine or spirit. None of these gave any new results.

2. The use of copper and silver colours as enamels, or under glaze, and their subsequent reduction by any of these agents. Sometimes there were good results, but the colour was always patchy.

3. The deposit of copper or silver from vapour of the chlorides, ammonium chlorides, or iodides, those portions of the glaze being protected which were to remain white. These experiments might be repeated with advantage. A similar one was the painting of the pattern in a susceptible glaze on a refractory one, and its exposure to vapour containing copper or silver. The suboxide of copper itself vaporises under certain conditions, which is the cause of the flown red colour occurring on many examples.

I have, of course, tried endless modifications of the ordinary process, such as using special woods for smoking, sawdust, shavings, paraffin, and other combustibles. Any of these answer the purpose, the application being slightly varied. But nothing material has come of any of these experiments, and the process remains substantially the same as at first. I believe that if there had been any new opening for the application of chemistry, although I might not have followed the clue successfully, I could hardly have missed it altogether.

In conclusion, I may say that I believe we have learned all there is to know of the chemical and mechanical side of the art, as it was known to the ancients. What remains to be discovered in order to produce original work, equal to that of the Renaissance, is not a technical mystery, but the secret of the spirit which animated the 15th century not only in Italy, but all through Europe. We have got the materials and many more, but the same causes that forbid the attainment of new beauty with the new ones, have stood between us and the revival of old beauty with the old. In saying this, I do not suppose myself to be going outside a universally accepted truth, or, at any rate, one that is very rarely questioned. Some day there may be a new imagery and a new art. In the meanwhile I can only say that if anyone sees his way to using the materials to good purpose, my experience, which I regard as an entirely chemical and mechanical one, is quite at his disposal.

DISCUSSION.

Mr. H. LONGDEN said he had no technical knowledge of this subject, but he had been in the habit of using Mr. De Morgan's lustre ware, and had sometimes told people that some day they would be very glad to buy it at high prices, because it would no longer be made, though it was now not rated so highly. It was principally red lustre, and he understood from Mr. De Morgan that there were difficulties with other colours; but he had seen some silver lustre, and had hoped that the pale green colour seen in the Italian ware might have been produced. There were two plates shown, about which he hoped they would hear something more; with a deep blue ground and a red lustre on a raised ornament. He once asked Mr. De Morgan to make some lustre tiles with a raised ornament on them, but difficulties occurred and they were not carried out. They owed a great debt to Mr. De Morgan for having produced this extremely beautiful work; the metallic quality seemed to him to be very wonderful. He remembered when a boy going to the Potteries and seeing work done very much like the Swansea lustre, which he was told was done with coal tar, but it soon rubbed off. This lustre, however, did not wear off, for he knew instances in which it had been in use for twelve years, and it remained as fine as at first. If anyone saw a fireplace lined with these tiles and the fire glowing upon them, they would appreciate the value of this work.

Mr. SPARKES said all would agree that they owed a great debt to Mr. De Morgan for the re-introduction of this beautiful ware. From his point of view, it was in all respects original, because the tint he produced was not similar to those on the old Hispano-Moorish ware. He should like to know if the difference between these strong copper colours and those of more delicate Hispano-Moorish tones was due to the copper, or to the smoke treatment, or whether anything was due to the tradition that the Eastern potters used southernwood as their smoke material. The subject was really so little known amongst potters, that criticism was not likely to produce much result. The trade was taking up the matter to some extent, and he had seen some fairly beautiful things produced by Mr. Maw, but not, in his opinion, equal in artistic beauty to those of Mr. De Morgan.

Mr. DE MORGAN said there was not such a very marked difference between all the Hispano-Moorish

specimens and those now shown. There was a great difference between the Swansea lustre, which was distinctly brown, and the Spanish, a piece of which was on the table; he did not know whether it was old, but the art there was so traditional, that it would fairly represent it; it looked quite a brilliant red by the side of the brown Swansea, but it also looked comparatively brown against one of his own, which had a crimson tinge. That was due to the thickness of the glaze, which had absorbed some oxide of copper. He believed the old processes were very quick, as the Italian process now was; not more than half the length of his own. His kilns were often fired for eight or ten hours, and he should think six hours would be a long firing in the old process. That made a difference in the suboxide of copper, which soaked into the glaze and produced the red colour, while still showing a metallic reflet. That really gave the most beautiful of the ruby lustres, which could be seen particularly in the Gubbio work. The Maestro Giorgio red was a deep transparent crimson, which did not interfere with the painting under the glaze. This could be seen in some of the specimens at South Kensington; it was like running a transparent crimson glaze over a monochrome drawing. He believed that was the main cause of the difference in colour. With respect to the use of southernwood, or rosemary, or any special fuel to produce the smoke, he did not think it could make any great difference. It depended far more on the speed with which it was administered, on the density of the smoke, and the degree of heat. All carbonaceous smoke, after all, consisted of the same ingredients chemically.

Mr. HUGH STANNUS said he knew nothing practically of this subject, but he must express his gratitude to Mr. De Morgan for the very interesting paper he had read. He had always thought that the reason this craft had died out was that the recipes had been forgotten. The advocates of Patent-laws said that, when an invention could be patented, the world got the benefit of it, but before that time, the inventor kept it as a secret for his own benefit and that of his family, and thus the knowledge of it might die out. But Mr. De Morgan had given another reason, and a very pregnant one, to all handicraftsmen. He had said that the use of lustre might have died, because it was difficult to combine it with the other colours; and that was probably the true reason why it was abandoned. He noticed that Mr. De Morgan distinguished between the old lustre, which was transparent, and that which is now produced, which is opaque, and would like to know if he ever made any which was transparent.

Mr. DE MORGAN said he could find one or two specimens which had a certain amount of transparency, and would probably allow a painting to show through. The most opaque were those on the top of an opaque tin enamel, and the most transparent on a thick transparent glaze.

Mr. STANNUS asked if he had made any attempts to paint a subject in ordinary colours, and then put a lustre on them afterwards. If that could be done, and the lustre were fairly transparent, it would lend additional value to the work. In conclusion, he felt that Mr. De Morgan was a perfect artist in this handicraft. He had made sacrifices of money, time, and even health, in its pursuit. He had told them of his failures as well of his successes; and often these were more instructive. This paper, when printed, would be exceedingly valuable, and would no doubt form an epoch in the art, like the treatises of Theophilus and Piccolpassi, from which new departures might be made.

Mr. FORBES ROBERTSON said Mr. De Morgan was an example such as one rarely met with, of a combination of artistic training and a scientific habit of mind; it was for lack of artistic training that our craftsmen in the applied arts had hitherto, in a great measure, failed to produce the artistic results which were so much to be desired. He did not think there were any chemical secrets known to the antique world which were not known, or on the point of being known, though we were not, perhaps, yet educated up to the same high sense of form as existed at the period referred to, viz., the half century in which the Renaissance found its zenith. He could not go into any of the technicalities of the subject, but desired to thank the reader of the paper for what he had put before them. He had devoted a lifetime to the subject; he was, in a measure, a born, as well as a trained, artist, and he inherited that scientific habit of mind which had served him so well. He could have wished that the paper had dealt somewhat with the correlated arts, and the political and international relations of the various States of Italy at that time with Spain, the Low Countries, and Germany. Mr. Stannus had touched on an important point when he said that perhaps one of the reasons for the decay in the manufacture of lustre ware was that certain secrets were in the keeping of certain families. They knew that in many of the arts in Italy there were branches which did die out with certain families, but in most cases, even including Venetian glass, they had been restored in our own time. Another reason might have been the political changes gradually going on in the Italian States of that day. The commerce of those great cities that brought about the revival of art, letters, and everything else was on the decline; the Portuguese and Spaniards were coming to the front, and it was in vain that the Venetians offered any money if the Portuguese discoverers would only let them act as their factors and agents for the sale of eastern commodities, especially spices, which up to that time had been in their hands. But the moment Vasco di Gama doubled the Cape the prosperity of Italy declined, and with it the arts also. However,

Mr. De Morgan might be assured that he had devoted himself to the most enduring of all the arts. Everything done by the hand of man in stone or metal would one day disappear, but thousands of years hence his little articles of pottery, however fragmentary, would remain. When all the other things which marked the state of civilisation at any particular period had gone, and when the names of all our living academicians were forgotten, bits of Mr. De Morgan's pottery would be found, and his name would be mentioned with respect.

Mr. TRICE MARTIN said he had had the pleasure of knowing Mr. De Morgan from boyhood, and remembered even his early attempts at art when at school. To illustrate the connection between the arts of Italy and the East, he might mention that he recently saw a pair of heavy Moorish stirrups, evidently made in the East. The shape was Eastern, the rough outer decoration and the inlaid work were Eastern, but outside they were covered with an excellent Italian enamel. They were apparently of 14th century workmanship.

Mr. PHENE SPIERS said he had had the pleasure of knowing Mr. De Morgan a great many years, and it was very seldom one met with such a combination of qualities — with scientific training, artistic perception, and a vivid imagination, all of which were apparent in his productions. It was interesting to notice how the scientific side of his character gave him such a mastery of the technical part of the process: whilst his artistic powers gave beauty to the objects produced. It was very fortunate for this branch of art that it was taken up by a man of so many sided a nature.

The CHAIRMAN, in proposing a vote of thanks to Mr. De Morgan, said he was not competent to deal with any of the technical questions raised in the deeply interesting paper they had just heard read, but, from his knowledge of the Indian potters' methods, he was of opinion that sufficient importance was not attached in England to the kind of fuel used in firing glazed ware, and that it was too severely scientific a dictum to say, as Mr. De Morgan did:—"Smoke is Smoke." In India—that is, more particularly in Scinde and the Punjaub—the utmost importance was attached to the influence of fuel in determining the tone, and even the tint of the colours to be developed; and as to whether, at a certain point, the flame of the fire should predominate or its smother of smoke. Of course, in India everything done was of religious prescription, and we had always to allow for that; but, at the same time, one generally discovered, even in the obscurest industrial processes followed by the Hindoos, that the religious prescription was based on immemorial experience of the technical results obtained. In a paper read by him many years ago in that place on "The Indian Potter," he gave a number of the recipes employed in the production of the glazed wares of Scinde, the Punjaub, and Madras, pointing out that while they never failed in developing the exact tone of colour required, the potters themselves attributed this entirely to the fuel in the furnace, whether of this or that wood, or goats' or other dung. As to the Spanish word, *azulejo*, "a tile," undoubtedly it originally meant a "blue-tile" [quasi azul-teja (compare Latin tegula, tegmen, tectum, and Tamil *tekka*, the *Tectona grandis*)]. In Minsheu [1599], the entry is "Azulejo, *a painted* tile, or *paving bricke, that is, of divers colours, blew clour;*" and azure itself is derived through the Low Latin *lazur*, and Low Greek *lazoúrion*, from the Arabic *lajwardi*, that is "lapis-lazuli," the blue stone from the Lajwurd mines in Badakshan, on the north-west frontier of India, whence comes also the Balas ruby; and *lajwurdee* is the name still sometimes given in north-west India to the turquoise blue tiles of Scinde and the Punjaub, and it is the origin of the frequent Anglo-Indian error of the colour of these tiles being prepared from "lapis lazuli." With regard to the question of the historical genesis of lustre ware, he believed it was far more ancient than the Saracens. The Saracens originated nothing in art, and it was time that people gave up all idea of there being any such thing as Saracenic or Arab art; and then many difficulties in connection with the history of the decorative arts would at once disappear. Delighting as they all did in sumptuary splendour, none of the Semitic races had ever shown any genius for the decorative arts. It should be remembered that at the time when Christianity began to gather force in Anterior Asia, and just before the irruption of the barbarians into the Western Roman Empire, the Greeks were rapidly discovering all the scientific secrets, the possession of which is the boast of modern civilisation. But just ere it reached the zenith of its evolution, ancient civilisation was overthrown at a blow by the Christianised Cæsars of Byzantium closing the schools of Greek philosophy at Athens, and of Greek science at Alexandria; and the rise of the Papal power at Rome on the ruins of the Western Empire, completed the catastrophe which involved Western Europe in the darkness of the Middle Ages for a thousand years. The Eastern Empire preserved its organisation for some time longer, and when at last despoiled of Syria and Egypt by the Saracens, Greek culture still retained sufficient vitality in Anterior, and, indeed, through the Nestorians, in Central Asia, to influence the wild Arab conquerors of those countries, not only in their arts and sciences, but in their political administration. The Arabs held their conquests in Africa and Syria, indeed only so long as the Greek principles of Government were followed by them. It was in a similar way that they entered into the inheritance of Greek science and Greek (Byzantine or Orientalised Greek) art, and thus preserved the traditions of both in Southern Europe, all through the night of the Dark

Ages. But they were nothing more than the diffusers of the science and art received by them from the Greeks, just as the Phœnicians had been the intermediaries before them in the propagation of Egyptian art among the natives of the Eastern basin, and of Greek art among those of the Western basin of the Mediterranean. There is no Arab art, not even in Arabia, and, to this day, all the arabesque embroidery of Egypt and Syria is done by Greek tailors. In conclusion, Sir George observed that it was a matter of the liveliest gratification to them all to have heard from the re-discoverer in this country of the lost art of lustre ware so full and unreserved an account of it; and, in reading his interesting paper on it, Mr. De Morgan had brought to a brilliant conclusion the Session of the Applied Art Section of the Society, so successfully opened last January by Mr. William Morris with his paper on "The Illustration of Gothic Books." He felt most grateful to Mr. De Morgan, and he begged to thank him most sincerely, not only on his own account, and for all present, but on behalf also of the Applied Art Section of the Society of Arts.

The vote of thanks having been carried unanimously,

Mr. DE MORGAN, in reply, said there was one point in which, to some extent, the paper might seem to be at variance with the remarks of the Chairman; but he wished it to be understood that, when he identified the era of Arab conquest with the extension of this particular secret, he was not committing himself to an opinion as to whether the Arabs were or were not artists. Only this particular thing somehow or other happened, that as they spread over Europe—or, rather, a certain length of time after—curiously enough these things appeared. There was a good deal to be said for the view that, even in Spain, the work was done by Persians. Señor Riaño mentioned that there was a colony of Persians in Andalusia, that Xeres was really Shiraz, and other things of the same sort, all pointing to the fact that the great promoters of the art were Aryans, and not Semites. Nevertheless, it was a curious coincidence that this particular form of art was always associated—at least, as to locality—with the Arab conquests. He concluded by describing the characteristics of several of the specimens exhibited.

Miscellaneous.

THE INDUSTRIES OF FINLAND.

M. Maurice Harbulot, writing in the *Monde Economique*, says that the most important industry of Finland—from the point of view of the value of the production—is that of wood-sawing by machinery. There are 253 important saw mills, employing 8,024 workpeople, and with a production valued at about £1,100,000. Eighteen of these establishments are situated in the towns, and the remainder in the rural districts. The cotton industry occupies the second place. This produces annually nearly £500,000, and is centralised in the hands of six proprietors. In the towns there are four cotton manufactories, employing 2,535 hands, and in the rural districts two establishments only, employing 1,174 workpeople. The following, in the order of their importance, come after the two chief industries. Wood polishing, manufacture of wood pulp, cellulox, and paper. Of these there are 28 establishments, employing 2,615 workpeople; value of the production, £420,000. Tanneries and leather factories number 602, and employ 1,903 workpeople. There are 35 foundries and establishments for making machinery; 84 breweries, 31 tobacco factories, 2 sugar refineries, 199 dairies, 1,350 mills, 1 linen factory, 32 brandy distilleries, &c. The total value of the industrial production of Finland was, in the latest year for which particulars are available, £4,933,000. At this period there were 6,018 industrial establishments, of which 3,005 were in the towns and 3,013 in the country districts. The number of workpeople engaged in the various industries was 45,335, of which 23,867 were employed in the towns and 21,468 in the country. On the 31st December, 1888, the population of the Grand Duchy amounted to 2,305,916, and there were, therefore, 19 persons engaged in the various industries of the country to every 1,000 inhabitants.

Correspondence.

THE EXTENSION OF COLONIAL TRADE.

The contribution of Mr. J. R. Carter, F.S.S., to the discussion on the paper read by Colonel Howard Vincent, is misleading in the following particular. He gives the value per head of exports of British produce from the United Kingdom in 1890 at £7 0s. 8d., and says that this amount per head is greater than at any previous time. This is true, if the term "any previous time" include only 1876 and the subsequent years, but it is incorrect if applied to the years 1872, 1873, and 1874. Taking the average of the five years, 1870-4, the value per head of exports of British produce is given in the Comparative Trade Statistics for 1854-90 as £7 7s. 3d. Again, in the Table at the end of his statement, Mr. Carter commences his statistics at the year 1876. If he had included the statistics for years 1870-74, they would have told a very different tale. The value of our average export of British produce to the United States in these five years was £33,000,000 sterling, whereas in 1890 the value was only £32,000,000 sterling. In 1872 our export of

British produce to the United States was valued at £41,000,000 sterling, the highest point it has yet reached. In the same year the value of our export of British produce to British North America was £10,000,000 sterling, and to Australia and New Zealand £14,000,000 sterling.

HOLT S. HALLETT.

It may be useful to offer some explanations of the important subject introduced to the Colonial Section by Colonel Howard Vincent.

One cause of conflict among the speakers was what is called "free trade," and the assumption that the great expansion of the industry and commerce of this country within the last forty years is due solely to "free trade."

Undoubtedly, as a doctrine of economic science, there can be no doubt that free trade, where there is free trade, must tend to promote commerce. Even the limited free trade or relaxation of fiscal regulations, which we have enjoyed for some years, must have been beneficial so far as it goes. This, however, is a very different thing from the assertion that the vast expansion of our industry and the increase in totals of values is to be assigned to "free trade."

This expansion is to be recognised, more or less, not only in this country, but in all the countries of the world, and that whether they have been under "free trade" or protection.

If an economist, like Mr. Bourne, sits down to write the history of the last half century, he must account not only for "free trade," but for the coincident circumstances. He must enumerate amongst others—

The gold discoveries.

The opening of the Pacific world to trade.

The advance in prices in India, China, Japan, &c.

The inventions of English speaking men on both sides of the Atlantic, of Bessemer, Siemens, &c., affecting productions and affecting prices.

The extension of railway and steamboat systems in all the countries of Europe and America.

The volume of produce has been increased and prices have been reduced, and by the energy of our people chiefly, these results have been produced in every region.

Sir Robert Peel and Mr. Cobden did not foretell the discoveries of gold in California, Australia, and South Africa (nor, it may be said, of silver), and to these rather than to the effect of "free trade" are large results to be attributed.

The trade to the Pacific countries alone now constitutes a great volume, and in this France, Germany, the United States, Holland, &c., largely share; and this, of course, is independent of "free trade" to them.

It is to those inventors who have been rewarded by our Society with the Albert Medal that the greatest economical operations are to be assigned and it is almost needless to point out that Sir H. Bessemer and the others were in no degree associated with the initiation of "free trade," though to them we owe the development of industry and commerce here, and in the United States, and on the Continent of Europe.

From the discussion now set on foot, we may eliminate "free trade" as a main cause, while recognising to the full, as a matter of economical doctrine, that free trade, if applied, is a valuable auxiliary of commerce.

There will also have to be considered how far the doctrines of economical science are to predominate, and how far the doctrines of another important science—that of political science—are to be applied. It may happen, after careful discussion, that there can be no demur to the theoretical acknowledgment of free trade, on one side, and no political or practical objection to the application of the measures advocated by Colonel Vincent, and those who gave him more or less support.

HYDE CLARKE.

32, St. George's-square, S.W.,
20th June, 1892.

General Notes.

NATIVE PASSENGER SHIPS IN INDIA.—According to a return recently issued by the Indian Government, the total number of people who sailed from Indian ports in native passenger ships, that is, sailed as passengers, being neither emigrants to the colonies nor pilgrims to the holy places in Arabia, was 1,001,892 in 1888-89, 1,081,403 in 1889-90, and 1,170,565 in 1890-91. The great bulk of these voyaged only within Indian limits, not more than 71,782 leaving India in the past year. Of those who left India, about three-fourths went from Madras Presidency to the Straits Settlements (18,804) and to Ceylon (36,586), most of the remainder going from Bombay and Karachi to the Persian Gulf (10,343), Mauritius, Zanzibar, Aden, and Trieste. The large number (1,098,783) who voyaged within Indian limits confined their migrations in the main to ports within their own Presidency, only 206,560 out of the whole number leaving their own Presidency or province to seek for work in other provinces. These migrations from province to province are practically limited to voyages undertaken by coolies from Madras and Bengal to Burma, and to the return voyages of coolies from Burma to their own provinces.—*Board of Trade Journal.*

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, JULY 1, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEW VICE-PRESIDENTS.

At a meeting held on Wednesday, June 29, after the Annual General Meeting, the Council elected (in accordance with the Bye-law passed at a General Meeting held on Wednesday, 18th May) the following gentlemen as Vice-Presidents of the Society:—The Attorney-General, Q C., M.P., for the years 1892 93 1893-94; Sir Philip Cunliffe-Owen, K.C B., K.C M.G., R. Brudenell Carter, F.R.C.S., Sir Edward James Harland, Bart., M.P., and John O'Connor, M.P., for the year 1892-93.

The terms of the Bye-law passed at the General Meeting held on Wednesday, 18th, are as follows:—"That in accordance with the proposal from the Council, the Bye-laws be altered and varied in such manner that the Council shall be empowered, during the years 1892 and 1893, to appoint not more than six members to be Vice-Presidents or other Members of the Council, in addition to those appointed under Bye-laws 79 and 84, and that the Council be empowered to determine the period or respective periods that members so appointed shall continue in office, not being later than the end of the Session commencing 1893, and that all Bye-laws which are inconsistent with such appointment and determination be suspended or varied."

CHAIRMANSHIP OF COUNCIL.

On Wednesday, 29th June, at their meeting, held after the annual election, the Council elected Sir Richard Webster, Attorney-General, Q.C., as Chairman, and Sir Frederick Bramwell, Bart., D.C.L, F.R.S., as Deputy-Chairman, for the ensuing year.

The various Committees were also re-appointed.

CONVERSAZIONE.

The Society's annual *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening, 29th June. The courts and galleries of the ground floors, and the galleries containing the Raphael cartoons, the Sheepshanks collection, the William Smith collection of water-colour drawings, the Dyce and Forster pictures, and the Chantrey bequest were open.

The company were received in the South Court by Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., and the following Vice-Presidents and Members of Council:—Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.; Alfred Carpmael; Michael Carteighe; Sir George Hayter Chubb; Major-General J. F. D. Donnelly, C.B.; Sir Henry Doulton; Professor Francis Elgar, LL.D.; C. Malcolm Kennedy, C.B.; Alexander B. W. Kennedy, F.R.S.; Sir Villiers Lister, K.C.M.G.; J. Biddulph Martin; Sir Owen Roberts, M.A., D.C.L., F.S.A.

Promenade Concerts were given by the Band of the Royal Engineers (conductor, Mr. Joseph Sommer), in the North Court, and by the Band of the Scots Guards (conductor, Mr. Edward Holland), in the Quadrangle of the Museum.

A Vocal and Instrumental Concert, by the Meister Glee Singers and the Meistersingers' Orchestra, was given in the Lecture Theatre under the direction of Mr. Norfolk Megone.

The number of visitors attending the *Conversazione* was 1,750.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 29th June. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., the Duke of Abercorn, C.B., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, James Dredge, Francis Elgar, LL.D., Sir Douglas Galton,

K.C.B., D.C.L., F.R.S., Thomas Hawksley, F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, George Matthey, F.R.S., and Sir Owen Roberts, M.A., F.S.A.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 29th June. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; Sir Frederick Abel, K.C.B., F.R.S., Sir Philip Cunliffe-Owen, K.C B., K.C.M.G., James Dredge, Sir Douglas Galton, K.C.B., F.R.S., George Matthey, F.R.S.

TRANSPORTATION COMMITTEE.

A meeting of the Transportation Committee was held on Thursday, 23rd June. Present: Francis Elgar, LL.D., in the chair; B. Francis Cobb, James Dredge, William Forbes, J. F. S. Gooday, Walter H. Harris, Charles Holmes, Pres. Inst. Brit. Carriage Manufacturers, George Norgate Hooper, Colonel Sir Nigel Kingscote, K.C.B., M.P.

DEPARTMENT OF ELECTRICITY.

The following circular to Exhibitors, from Mr. J. P. Barrett, Chief of the Electricity Department, has been received:—

It is the purpose of the Exposition management to allow exhibitors to completely equip the Electrical Building for lighting and power. With a view to determine just what may be done in this direction, the Department of Electricity chooses to place its plans before those who are interested in its success, and advise with them as nearly as may be, with a view to give them an opportunity to participate in this equipment.

Under the rules of the Exposition it will be necessary to plant all operating machinery in what is to be known as the general power plant in Machinery Hall, 700 feet from the Electrical Building. All generators will be established at that point immediately adjacent to steam power of competent capacity. Between this power plant and the Electrical Building there is a subway six feet deep and six feet wide, for the accommodation of conductors. Fire-proof vaults will be built at the point of entrance to the Electrical Building in which to instal transformers, to comply with the National Underwriters' requirements. Headway averaging 7 feet under the flooring, and foundation posts at intervals of 12 feet, will give ample wiring facilities.

It is the purpose to divide the building into equitable sections, and to assign these sections to the various exhibiting interests. Those to whom assignments are made will be expected to instal their own generators, furnish cables between the plant and the building, and do all wiring, including the furnishing of wire. Those who are given arc lighting to do will be expected to furnish carbons, and attend to renewing same. Those undertaking to operate incandescent lamps will be expected to furnish all renewals and attendance. In addition to these items of expenditure, all exhibitors whose generators are operated from steam in the power-station will be asked to pay, *pro rata*, the costs incident to the erection of the machinery. Belting, from shafting to generators, must also be furnished by exhibitors: and exhibitors of alternating systems will be asked to contribute to the expense of constructing the transformer vault.

The building will be equipped for 500 horse-power for the operation of motors, 500 horse-power for arc lights, 500 horse-power for incandescents, and a reserve of 500 horse-power for extra incandescents, applications for most of which are already in.

In order that the plant for this building may not be a source of expense to the Exposition management, a charge will be made for any special arc lighting desired by exhibitors who do not participate in the equipment and electrical supply of the building, also against the same class of exhibitors who desire power for motors or who require incandescent lamps. These charges do not concern any who contribute to the expenses cited above.

In order that the above proposed system may be reduced to a definable quantity, I beg leave to submit the enclosed blank, which please fill out completely, and return to me at once.—Very respectfully,

J. P. Barrett,
Chief of Department.

Copies of the form can be obtained on application to the Secretary to the Royal Commission.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report from the Council, and the Treasurers' Statements of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 29th June, at four p.m., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, in the chair.

The Assistant-Secretary read the notice convening the meeting, and the minutes.

The CHAIRMAN read the following letter, written by the Secretary to the Chairman of the Council, Sir Richard Webster, who was unavoidably prevented from presiding at the meeting :—

June 14, 1892.

DEAR SIR RICHARD,—May I ask you to express to the meeting my extreme regret at my enforced absence. I am sure the meeting will understand that I am doing more useful work for the Society in America than I could do by remaining in England, and they will therefore excuse my absence from so important a part of my duty as attendance at the Annual General Meeting.

Yours faithfully,

H. T. WOOD, *Secretary*.

The Attorney-General, M.P.

The following candidates were proposed, ballotted for, and duly elected members of the Society :—

Benson, George Henry, Holly-lodge, St. Saviour's, Jersey.
Blott, Walter, Manningdale, South Norwood, S.E.
Brooke, Wilton, Ashville, Stairfoot, near Barnsley.
Broomhead-Colton-Fox, Barnard Platts, Wales, Kiveton-park, Yorks.
Cassavetti, John, The Cedars, Torquay, and Exeter College, Oxford.
Chaney, Henry James, 7, Old-palace-yard, Westminster, S.W.
Corsan, John Richard, 58A, Gray's-inn-road, W.C.
Elliot, John, Derwent-house, Upper Villiers-street, Wolverhampton.
Ellwood, Thomas Ashcroft, 13, Cavendish-road, Harringay, N.
Farquharson, Lieut.-Colonel J., R.E., Ordnance Survey-office, Southampton.
Foster, Charles Rolls, 54, Pall-mall, S.W.
Fry, Joseph, 48, Royal Exchange, Manchester.
Gaze, Harry E., Oakhurst, Ravenscourt-square, Hammersmith, W.
Harland, Sir Edward James, Bart., Baroda-house, Kensington-palace-gardens, W., and Glenfarne-hall, Enniskillen, Ireland.
Jones, John, 40, Sydney-street, S.W.
Ketchley, Rev. H. E., B.A., Devon-lodge, Malvern.
Little, Thomas David, Public Works Department, Bombay, India.
Logan, David, care of Henry S. King and Co., 65, Cornhill, E.C.
Loyd, William Graham, 122, Cannon-street, E.C.
Lyon, John George, Knottingley, Yorks.
Marshall, William Bayley, Richmond-hill, Birmingham.
Mason, Francis Herbert, 9, Pall-mall, S.W.
Minty Samuel, The Triangle, Bournemouth, Hants.
Munro, Hon. James, Grand Hotel, Charing-cross, S.W.
Shackleford, Arthur Lewis, 223, Bristol-road, Birmingham.
Shaw, William Thomas, 110, Bunhill-row, E.C.
Skinner, Arthur B., B.A., 2, The Residences, South Kensington Museum, S.W.
Tattersall, William, 90, Arden-terrace, Accrington, Lancashire.
Taylor, John, 15, Lucius-street, Torquay.
Wansbrough, Cecil Shartman, Arlington-villa, Barrow-in-Furness.
White, Henry, 80, London-road, Carlisle.
Wurtzburg, John Henry, care of Greenwood and Batley, Albion Works, Leeds, and 2, De Grey-road, Leeds.

The CHAIRMAN nominated Mr. Wyatt Papworth and Mr. John Jewell Vezey scrutineers, and declared the ballot open.

The ASSISTANT-SECRETARY then read the following

REPORT OF THE COUNCIL.

I.—ORDINARY MEETINGS.

The Session commenced, as usual, with an address by the Chairman of the Council. The principal subject dealt with in his address by the Attorney-General was the connection of the Society of Arts with Exhibitions in the past, and its special association in the future with the Exhibition at Chicago, and he concluded by impressing on his audience the importance of this country taking an adequate part in the Columbian Exposition of 1893.

The same subject was treated in a paper a few weeks later by Mr. James Dredge; this paper contains the fullest account which has yet appeared on the scope and organisation of the Exhibition. The same subject lent a special interest to a paper read in the latter part of the Session by Mr. Robert S. McCormick, the resident Commissioner for Great Britain of the World's Columbian Exposition, on "The Future Trade Relations between this Country and America." Mr. McCormick pointed out that the United States were now pressing Great Britain hard in many markets of the world, and that they were likely to urge their claims still more vigorously in the future. He also showed that the growth of manufactures in the States was working a revolution in the trade between this country and America, and pointed out the advantages to be gained for our industries by a good representation in the British Section at Chicago. The subject of our trade relations with foreign countries was also dealt with by Mr. Ewing Matheson in a popular manner in his paper on "Foreign Exchanges."

At the first meeting after the opening address, Professor Silvanus P. Thompson, to whom the Society is indebted for many important contributions in the form of lectures and other communications, read an interesting and important paper on the measurement of lenses, and described the apparatus he has devised for the purpose. Other papers dealing with optical subjects were those by Dr. Edridge-Green, on "Lovibond's Tintometer," and by Capt. Abney, on "Colour Blindness." A domestic bereavement rendered it impossible for Capt. Abney himself to read his paper, but the Society is much indebted to his colleague at South Kensington, General Festing, for not only reading the paper, but also for supervising the conduct of the very beautiful experiments illustrating the results of Capt. Abney's recent work with which General Festing had been intimately associated. With these papers should be mentioned the one contributed by Mr. Ives, the distinguished American student of photographic chemistry. In it was described the very beautiful device by which the author has succeeded in reproducing to the eye the actual colours of the object photographed, either on a screen or in an apparatus as portable as an ordinary spectroscope. It is to be remembered that Mr. Ives's invention has nothing in common with the many attempts to produce photographs in colour by chemical means.

Electricity has not taken so prominent a place among the subjects dealt with before the Society at the ordinary meetings as in some recent years, but there were two papers coming under this head, one by Mr. G. H. Robertson, on "Secondary Batteries," giving the results of much valuable and original work, and one by Mr. J. N. Shoolbred, describing the successful arrangements which have been made by the Bradford Corporation for the supply of electricity to that town.

Mr. A. P. Laurie, whose lectures on the "Pigments and Vehicles of the old Masters," referred to in a later part of this report, gave in his paper on the "Durability of Modern Pigments," the results of some further experiments he has been carrying on since the date of his paper read before the Society on the 8th April, 1891. Another paper dealing with matters of an artistic nature was that of Mr. Ernest Hart, on "Ancient and Modern Art Pottery of Japan," a subject on which he is one of our leading authorities.

Two papers may be classed as dealing with geographical topics; in one Capt. Younghusband gave an account of his recent enterprising and important explorations in the Pamirs; in the other, Dr. Tempest Anderson described the less distant and more familiar districts of Iceland which he had lately visited.

Egyptian agriculture formed the subject of an important paper by Professor Wallace, which had to be read in the absence of the author on account of his sudden illness. Prof. Vivian B. Lewes, in his paper on the "Spontaneous Ignition of Coal," carried on further the subject which he brought before the British Association, at its meeting last autumn, and made numerous practical suggestions with reference to the sea carriage of coal. Mr. Price-Edwards, whose paper on "Experiments with Lighthouse Illuminants at the South Foreland" (read before the Society on the 10th March, 1886) will be in the memory of those interested in lighthouse matters, supplemented it this Session with a paper on "Burning Oils for Lighthouses and Lightships."

General Pitt Rivers gave an account of the system he has elaborated for the arrangement of Museums, a subject with which the Society has long been associated, and in which its members take great interest. Mr. T. Pridgin Teale's paper on "Dust" was of practical value, and was the only one treating of a sanitary question read during the Session. Mr. Addenbrooke, in his communication on the "Uses and Applications of Aluminium," showed how rapidly the reduction in price of this remarkable metal is extending its useful applications. Mr. Gilbert R. Redgrave, in his paper on the "Manufacture and Industrial Application of Flexible Tubing," gave an account of the very ingenious method by which a coiled metal tube is made at once quite flexible and perfectly water-tight.

II.—INDIAN SECTION.

Seven meetings in all have been held. The Session opened on January 21st, when Mr. Herbert Jones, a young traveller of ability and promise, described to a large audience an interesting journey made by him on the Russo-Chinese frontier, from Tien-Shan to the Pamirs. A feature of the discussion was the manner in which Mr. Jones's sympathetic references to Russia's colonising work were endorsed by most of the speakers, including the well-known Asiatic traveller, the Rev. Dr. Lansdell, and the distinguished Anglo-Indian Chairman, Sir W. W. Hunter. To geographers this

paper was of special interest, Mr. Jones having been the first Englishman, as Dr. Lansdell pointed out, to cross the Tien-Shan mountains from Viernay to Kashgar. The second meeting took place on February 11th, when Lord Lamington delivered to a crowded assembly a graphic account of his not unadventurous wanderings in the Northern Shan States, a part of the world that has come more prominently into public notice since our annexation of Upper Burma. Amongst those who took part in the discussion were Sir Steuart Colvin Bayley, and Sir Charles Crosthwaite, whose remarks on the opening up of the country by railways were of value, as proceeding from an official of his experience. On March 3, Surgeon Major-General Sir William Moore, honorary physician to Her Majesty, contributed a useful paper on "Indian Sanitation and the International Congress of Hygiene." His paper may be commended to the notice of those foreign hygienists who are constantly heaping abuse on India as the "origin and home of cholera." "What has been done," said Sir W. Moore, "is not brought out sufficiently prominently, and I look forward to its being demonstrated at future Congresses that India is not so much behind in sanitation as is generally believed." In the meantime it may be hoped that Sir W. Moore's own paper will help to dispel some of the erroneous notions to which he referred. Major-General Sir Owen Burne presided, and, together with Sir Douglas Galton (chairman of the Organising Committee of the Seventh International Congress of Hygiene and Demography), Surgeon Lieut.-Colonel Hendley, and others, took part in an instructive discussion. On March 24, a spirited defence of the opium trade was made by Mr. G. H. M. Batten, formerly of the Indian Civil Service, and the discussion which followed the reading of a very instructive paper is generally admitted to have been the most important that has ever taken place on this much-debated question. Sir Thomas Wade, Mr. Horatio Nelson Lay, and Sir Lepel Griffin, supported Mr. Batten's arguments, while Mr. Samuel Smith, M.P., and Mr. J. G. Alexander spoke from the point of view of the Society for the Suppression of the Opium Trade. As there was not time to finish the discussion, those who had sent up their names were invited to write out their remarks for publication in the Society's *Journal*. The desire of the Society to give a fair hearing to both sides in the controversy seems to have afforded much satisfaction. On April 7th, Dr. J. Augustus Voelcker, in an excellent paper on "The Agricultural Needs of India," summed up the results of his recent official visit to the East. Sir John Strachey presided, and practical speeches were delivered by General J. Michael, the pioneer of forestry in India, Sir Charles Bernard (Secretary of the Revenue Department, India-office), Lord Reay, and several other gentlemen of eminence, who explained what is being done in the Western Presidency to introduce improved agricultural methods. On April 2nd, Sir William Wedderburn, Bart., in a paper on "The Reorganisation of Credit in India," pleaded for the establishment of land banks. The final meeting was held on May 19, when a most valuable paper, by Mr. J. A. Baines, on "The Administration of the Imperial Census of 1891 in India," was read, and amongst the speakers was Sir W. C. Plowden, K.C.S.I., M.P., Mr. Baines's predecessor in the office of Chief Census Commissioner for India.

III.—Foreign and Colonial Section.

At the opening meeting of the Session, Mr. Ernest Satow, C.M.G., read portions of a journal which he kept while on an official tour through the Laos States of Upper Siam, and gave an interesting account of the people, trade, and geographical features of that little known region. Mr. Satow having kindly left his journal with the Society, it is intended to publish a further extract therefrom in the autumn.

On February 16th, Mr. Lewis Atkinson, the manager of the forthcoming Exhibition at Kimberley, South Africa, read a paper descriptive of the objects for which that Exhibition is being promoted, and the inducements held out to British manufacturers to be represented. The paper was supplemented by an interesting collection of photographic views.

The paper read at the meeting held on the 15th March had as its subject, "Peru: its commerce and resources." The author, Mr. F. A. Pezet, Consul-General for Peru in this country, described with much completeness the natural wealth of Peru and the growing importance of its manufactures. He urged the need of capital in promoting sound native industries, and the suitability of certain portions of the country for immigration.

On April 5th, the Rev. John McLean delivered an interesting address upon the "Red and White Races of Manitoba and the

North-West." He testified to the success which had attended the policy of the Government of the Dominion in its dealings with the Indians.

At the meeting on April 26th, Sir Edward Braddon, K.C.M.G., read a paper on "Australasia: its progress and resources." He gave a most striking account of the struggles and privations of the early settlers, and sketched the development of all the Australasian Colonies. In the discussion which followed, the financial policy of these colonies was justified by the Agents-General present.

The concluding paper of the Session was entitled "The Extension of Colonial Trade," and was an appeal by its author, Colonel Howard Vincent, C.B., M.P., for a preferential tariff in favour of colonial and Indian goods.

IV.—Applied Art Section.

Mr. William Morris opened the Session of this Section on January 26, with a paper on "The Woodcuts of Gothic Books," in which he pointed out the distinctive characteristics of the various classes of illustrated books produced during the 15th and early years of the 16th centuries. Mr. Morris showed a fine series of lantern slides of the woodcuts of the different schools, and drew especial attention to the fact that, in these old illustrated books, the illustrations did not bear a mere accidental connection with the other ornament and the type, but that the whole book formed one harmonious work of art. He further urged that this same principle should guide the production of the illustrated books of to-day.

At the meeting of February 23, Mr. J. William Tonks read a paper on "The Artistic Treatment of Jewel and Address Caskets," in which he traced the history of these artistic objects from the earliest times, showing the great variety of forms in which they were produced. He also described some of the most important specimens of modern caskets. The paper was illustrated by some fine examples of old caskets, selected from the South Kensington Museum, which were kindly lent by the Science and Art Department.

At the third meeting, on March 29, Mr. E. Roscoe Mullins drew attention to "The Decorative Uses of Sculpture," and showed in his paper how sculpture was at its best when treated in connection with architecture, and how unsatisfactory in treatment and position the isolated statue really is. Mr. Mullins advocated the filling-up of the niches of our public buildings, such as St. Paul's Cathedral, with statues of great men. The paper was illustrated by lantern slides of fine examples of decorative sculpture, from Assyrian to modern times.

Mr. C. Purdon Clarke read a paper on "English Brocades and Figured Silks," on April 12, in which it was shown that English silk manufactures were slowly emerging from a long period of depression, and that fine ornamental silks could now be produced in England at a lower price than would be charged either in France or Germany. Mr. Purdon Clarke collected, for exhibition at the meeting, a magnificent series of silks manufactured in England, which were exquisite in colour, elegant in design, and superb in texture.

It was announced that Mr. George T. Robinson would read a paper on "Decorative Plaster Work," on May 17, in continuation of his valuable paper last Session on "Modelled Stucco Work," but, unfortunately, he was prevented by illness from carrying out his intention, and Mr. William Simpson kindly undertook to take his place with a paper on "Mud, a Material in Persian and Eastern Architecture." Mr. Simpson showed in this paper, from his own large experience, how extensively mud has been used as an architectural material, and how much light the investigation of the various examples throws upon the history of architecture.

The last meeting, on May 31, was devoted to a paper on "Lustre Ware," by Mr. William De Morgan, in which he traced the history and explained the technique of this beautiful art product. In illustration of the subject of his paper, Mr. De Morgan exhibited a small collection of specimens of modern lustre ware, which were remarkable for the vigour of their decoration and the beauty of their colour.

V.—Cantor Lectures.

The first of the series of Cantor Lectures for the present Session was by Mr. A. P. Laurie, the subject being, "The Pigments and Vehicles of the Old Masters." The lectures contained the results of Mr. Laurie's own investigations, and may be commended to the notice of artists, as also the lectures and papers on the same subject by Mr. Laurie himself, Mr. Holman Hunt, and Professor J. M. Thomson. Professor George Forbes, in his lectures in 1888, elaborated the principles on which, so far as is at present known, electrical distribution may be based. In the course which he delivered after Christ-

mas, he showed how electrical science had been developed since the date of his previous course. He was followed by Professor William Robinson, who gave an account of the increasing uses of petroleum engines, and pointed out the advantages belonging to this type of motor. The next series was by Mr. Bennett H. Brough, on "Mine Surveying," an important subject which has not hitherto been treated in any series of Cantor Lectures. The concluding course of lectures for the session was by Dr. Percy Frankland, on "Recent Bacteriological and Chemical Research in connection with the Fermentation Industries." Professor Frankland gave a very lucid exposition of the recent advances which had been made on the study of micro-organisms, and the industrial applications of that study.

VI.—Juvenile Lectures.

The usual short course of lectures, adapted for a juvenile audience, were given during the Christmas holidays, the lecturer being Prof. J. M. Thomson, and the subject, "The Three States of Matter: solid, liquid, and gaseous." The lectures, which were well received and gave great satisfaction to the audience, were illustrated by a brilliant series of experiments, arranged by Prof. Thomson and his assistant, Mr. Jackson.

VII.—Howard Lectures.

It was announced, in the last report of the Council, that Professor Unwin had undertaken to deliver a course of lectures on "The Development and Transmission of Power from Central Stations." Unfortunately, after all the arrangements had been made, Professor Unwin was prevented by illness from carrying them out. He has, however, promised to give the course during the next Session.

VIII.—Albert Medal.

The Albert Medal for the present year has been awarded by the Council, with the approval and sanction of the President, H.R.H. the Prince of Wales, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

IX.—Medals for Papers.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1891-2:—

At the Ordinary Meetings:—

To Prof. Silvanus P. Thompson, F.R.S., for his paper on "Measurement of Lenses."

To G. H. Robertson, F.C.S., for his paper on "Secondary Batteries."

To Captain F. E. Younghusband, for his paper on "The Pamirs."

To Prof. Vivian B. Lewes, for his paper on "Spontaneous Ingnition of Coal, and its Prevention."

To Robert S. McCormick, for his paper on "The Trade Relations of Great Britain and the United States."

To Captain W. de W. Abney, C.B., F.R.S., for his paper on "Colour Blindness."

To F. E. Ives, for his paper on "Composite Heliochromy."

In the Foreign and Colonial Section:—

To F. A. Pezet, for his paper on "Peru: its Commerce and Resources."

To Sir Edward Braddon, K.C.M.G., for his paper on "Australia: its Progress and Resources."

In the Indian Section:—

To G. H. M. Batten, for his paper on "The Opium Question."

To Dr. J. Augustus Voelcker, for his paper on "The Agricultural Needs of India."

To Jervoise Athelstane Baines, for his paper on "The Administration of the Imperial Census of 1891 in India."

In the Applied Art Section:—

To William Morris, M.A., for his paper on "The Woodcuts of Gothic Books."

To C. Purdon Clarke, C.I.E., for his paper on "English Brocades and Figured Silks."

To William De Morgan, for his paper on "Lustre Ware."

Mr. Dredge, being a member of Council, and, therefore, under the usual practice of the Council in such cases, not eligible for the award of a medal, thanks were voted to him for his paper on "The Columbian Exposition at Chicago, 1893."

X.—Mulready Prizes.

As announced in last year's report, the Council are offering, under the Mulready Trust, two Gold Medals, or two prizes of £20 each, for competition among the students of Schools of Art in the United Kingdom in 1892 and 1893, one in each year, for drawings from the nude. The Science and Art Department have consented to assist the Society by allowing the adjudication to be made by their Examiners.

XI.—Stock Prize.

The Council have also offered under the John Stock Trust a Gold Medal, or a prize of

£20, to the student of a School of Art who shall send in at the competition of 1892 the best original design for architectural decoration, by means of wall-painting, stucco, carving, mosaic, or any other method. As in the case of the Mulready Prize, the adjudication will be made by the examiners of the Science and Art Department.

XII.—Owen Jones Prizes.

The prizes have been awarded annually, since 1879, on the results of the annual competition of the Science and Art Department, to students of the Schools of Art who produce the best designs for household furniture, &c., on the principles laid down by Owen Jones. As usual, six prizes were offered last year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.* An equal number of prizes has been offered for the present year (1892), and the result of the competition will be published in the *Journal* as soon as it is received from the Science and Art Department.

XIII.—Fothergill Prize.

In answer to the offer made, as stated in the last report of the Council, under the terms of the Fothergill Trust, of a Society of Arts Gold Medal or £20, for "the best Invention, having for its object the Prevention or Extinction of Fires in Theatres or other places of amusement," eighteen competitors submitted designs, models, essays, samples, or suggestions. The Committee appointed to consider the award reported that, after a careful examination of the various proposals, they could not find any one which was, in their opinion, of sufficient merit, and coming sufficiently within the terms of the offer, to justify them in recommending it for the distinction of a Society of Arts Medal.

The Council regret that the offer should not have produced more satisfactory results, but they agree with the Committee, that no good purpose would be served by making an award to any invention which was not of decided novelty, importance, and value, and the competition was not successful in bringing out any such invention. The Council have, however, decided to publish in the *Journal* an essay sent in by Mr. E. A. Woodrow, which, although useful, did not, in their opinion, come within the terms of the offer.

* See *Journal* for September 18, 1891, p. 823.

XIV.—Benjamin Shaw Prize.

It was announced in the last report of the Council that they had asked the Committee of the International Congress of Hygiene to assist them in awarding the prizes founded by Mr. Benjamin Shaw for Industrial Hygiene. Unfortunately, but little response was made to the offer, and of the few competitors who entered none were recommended by the Committee of the Congress as suitable for the award.

XV.—Prizes for Drawing.

For the past three years the Council have offered twelve Bronze Medals for drawings sent in by students to the annual exhibition held by the Drawing Society, which, during its four years of existence, has greatly stimulated the teaching of drawing in the upper schools. The annual exhibition of 1892 showed how many different kinds of drawing are useful in developing the society's plan of making drawing a means of general education. The exhibition consisted of 529 drawings by about 500 boys and girls selected from nearly 15,000 in 78 public schools, high schools, and grammar schools. In addition to carrying out the work of the exhibition, the society holds annual examinations for schools, and awards certificates to competent teachers. The Council feel assured that useful work is done by this society in encouraging the study of drawing in middle-grade schools, and have, therefore, acceded to the application of the Drawing Society to renew the offer for next year.

XVI.—Memorial Tablets.

No tablet has been erected since the last year's report, but one is now in hand, and will shortly be placed on Bertram-house, Hampstead, where Sir Rowland Hill, the founder of the penny post, resided, from 1849 until his death, on 27th August, 1879. The house is now in the possession of the Metropolitan Asylum Board, who have given permission for the erection of the tablet.

XVII.—Examinations.

The number which entered for the Society's Examinations shows a gratifying increase, 2,928 having been examined, which is the largest number of candidates who have ever presented themselves to the Society of Arts Examinations since their institution in 1856, being an increase of 261 upon last year, when the numbers were 2,667. The numbers of papers

worked was also nearly equal to the largest number produced under the original system of examinations when the subjects had a far wider range than at present. In 1869, 2,160 candidates were examined; at that time the Examinations were free, and there was a choice of 36 subjects. The number of papers worked in that year was 3,193; this year, with only 17 subjects, 3,143 papers were sent in.

The standard may also be taken to be improving, for the number of First-class certificates which will be issued is 379. Last year there were 295, when 2,460 candidates were examined; 939 Second-class certificates, and 1,180 Third-class will be issued this year. The actual number of failures (645) is less than last year, when the failures to pass amounted to 651.

The largest number of candidates was as usual attracted by Book-keeping, for which 1,375 entered. The next largest was in the subject of Shorthand, 616. In English there were 156, French 155, Arithmetic 123, German 122, Spanish 90, Italian 9, Portuguese 5, and 98 for Typewriting.

Neither Russian, Danish, Chinese, nor Japanese attracted any candidates.

Domestic Economy, for which the number in recent years has not been very large, shows a considerable increase, 123 candidates having been examined. Last year there were only 43. In Theory of Music there has been considerable increase this year, 239 candidates having entered as against 131 last year. In previous years this subject has shown a decline.

The offer of medals, and of the prizes for which the Society is indebted to the liberality of various of the City Companies, has certainly been, during the past two or three years, of considerable value in raising the standard of the Examinations, and it is probable that the increased proportion of First-class certificates may, to a very large extent, be attributed to these offers. The Council hope that the Companies—viz., the Goldsmiths, Mercers, Skinners, Salters, and Clothworkers—who have assisted in the past, will continue their liberal aid in the future.

It should be added that the Special Examination for School Board teachers, to which reference was made in the last Report, was duly held, as announced, in September. For this examination 423 candidates were examined, and there were awarded 12 First-class, 117 Second-class, and 196 Third-class certificates. These numbers should be added to the totals of the regular examinations, which were held in March last. A total number is thus reached of 3,351 persons examined by the Society during the Session just completed.

XVIII.—Practical Examinations in Music.

The number of candidates examined this year is 245, showing a decrease on that for 1891, when 276 were examined. The increase last year was no doubt due to the offer of medals, which induced many candidates of former years to present themselves again with the view of obtaining a medal. This year eight candidates obtained full marks, and will, in consequence, receive Bronze Medals. As several candidates took more than one subject, there were 262 examinations, resulting in the award of 102 First-class and 132 Second-class Certificates, only 28 being failures. Two candidates entered for the Honours Certificates, but neither was successful.

XIX.—Standard of Colour.

The Committee which, as stated in the last report of the Council, was appointed last Session to consider the practicability of formulating a standard of colour for practical purposes, has held several meetings. They have decided on a list of names for standard colours, and have selected tints which they consider represented by those names. Captain Abney has very kindly undertaken to examine all these colours and to prepare, by means of his colour-patch system, a formula for each of them, by means of which a patch of light accurately representing the standard colour can be produced at any time and place. The Committee hope that, when their work is complete, the list of standard colours thus produced may be of practical value for many industrial applications.

XX.—Chicago Exhibition, 1893.

Among the most important departments of the Society of Arts' work during the past year has, as the members are well aware, been in connection with the great International Exhibition which is to be held at Chicago next year.

In March, 1891, Mr. Robert Lincoln, the American Minister to Great Britain, made on behalf of his Government a formal application to Lord Salisbury, asking that this country should take part in the proposed Exhibition, and received the reply that a Royal Commission should be appointed for the purpose.

No immediate action was taken, but as the result of some informal negotiations, the

Under Secretary of State for Foreign Affairs, in June of last year, applied to the Attorney-General, the Chairman of the Council of the Society, to know whether the Society would undertake the duties connected with the organisation of the British section of the Chicago Exhibition if a grant of £25,000 were appropriated by the Treasury for the purpose.

The proposal was, in the first instance, submitted to H.R.H., the President of the Society, and was approved by him. The Council then went very carefully into the question, and came to the conclusion that if the exhibitors were willing, as in the case of the Paris Exhibition of 1889, to bear a share of the expenditure, the grant proposed might be made to suffice. They accordingly requested their Chairman to submit a memorandum stating the conditions on which they would be willing, on behalf of the Society, to undertake the proposed duties.

On the 9th July, Sir James Fergusson, as Under Secretary of State for Foreign Affairs, addressed a letter to the Attorney-General stating that the Lords of the Treasury would accept the offer of the Society to undertake the organisation of the British section in Chicago in 1893, and that they had requested tho Home Office to take the necessary steps for constituting the Council of the Society for the time being, a Royal Commission for this purpose.

This Commission was actually issued on the 26th August, but in the meantime the Council of the Society had anticipated their appointment by communicating with the India Office and the Colonial Office, and requested that steps might might be taken to inform the British colonies and the Indian Government of the action which Her Majesty's Government proposed to take with regard to the Chicago Exhibition.

They had also the pleasure of receiving the Special Commission sent over by the Board of Managers of the Exhibition with the view of securing the co-operation of the various European Governments. This Commission, which consisted of the Hon. Benjamin Butterworth, Judge Lindsay, Mr. Ferdinand Peck, Major Handy and Mr. W. H. Bullock, arrived in England in July, 1891. Their visit was of great value in providing information as to the general scope and character of the Exhibition, and of the organisation which was provided for carrying it out. In the report which they made on their return, they expressed in warm terms their appreciation of their reception here, and their belief that it largely contributed to the ultimate success of their mission.

The first meeting of the Royal Commission was held on the 3rd September, when instructions were given to Sir Henry Trueman Wood, who had been appointed Secretary to the Commission, to proceed to Chicago for the purpose of making all the necessary preliminary arrangements. Mr. Dredge, one of the members of the Commission, kindly volunteered to accompany Sir Henry Wood, and these two gentlemen were authorised to visit Chicago on behalf of the Commission. On their return they made a joint report, which was submitted to the Commission on the 21st October, and appeared in the *Journal* of the Society on the 23rd October. The Royal Commission are also much indebted to Mr. Dredge for the admirable paper which he read before the Society on the 9th December,* giving a very full description of the Exhibition buildings, and of the preparations which had been made for the Exhibition.

As soon as the necessary information had been obtained, a circular was issued to those firms who had taken part in recent International Exhibitions, and to a large number of firms who might be likely to exhibit at Chicago, inviting them to take part in the Exhibition. Advertisements were also inserted in the principal English, Scotch, and Irish newspapers. The limited amount of the grant made by the Government rendered it necessary that the amount should be supplemented by charges for the space occupied by exhibitors, and, indeed, the grant was made on that understanding. A sliding scale was arranged, under which the highest charge was 5s. per square foot of superficial area, the lowest 2s. 6d. per square foot; the amount varying according to the size of the space proposed to be occupied by the exhibitor.

The date by which all applications were to be received was fixed for the 29th February, 1892. In answer to the circular, a large number of applications were received, though it was found that the high Customs' duties now levied in the United States deterred manufacturers in many important departments of industry from taking part in the Exhibition. Some, but not many, objections were also taken to the charge for space.

When the vote on account came before the

* The paper appeared in the Society's *Journal* on the 11th December.

House of Commons in Committee of Supply, great exception was taken to the smallness of the amount granted, and there was a strong expression of opinion from all sides of the House that the amount should be largely increased. The Commission fe .themselves justified by this expression of feeling in urging upon the Chancellor of the Exchequer the desirability of placing a larger sum at their disposal, especially in view of the fact that the contributions of all the other great countries which proposed to take part in the Exhibition were on a much more liberal scale. As a result of this application, which was strenuously supported by the Chairman of the Commission, Sir Richard Webster, the Chancellor of the Exchequer, on the 14th April, 1892, intimated that Her Majesty's Government were willing to increase the grant to the Royal Commission from £25,000 to £60,000, on the understanding that space should be provided free to British exhibitors.

The natural result of this liberality on the part of the Government has been a considerable increase in the number of applications, and although these received since April last include a considerable proportion of a less important class than received under the earlier arrangement, there are yet a number of very important firms who have decided to exhibit now that space is free, but who would not have done so had payment for space occupied been added to the very heavy charges which are of necessity incurred by exhibitors at a foreign Exhibition.

The Council have much pleasure in informing the members that they have no fear as to the adequate representation of the industries of Great Britain and Ireland as a whole, although there are, of course, important branches of industry which are so affected by the present high Customs tariffs of the States, that they will not be sufficiently represented at Chicago.

The buildings in which the exhibits will be placed will be provided in a completely finished condition by the American Executive, but the Royal Commission have thought it desirable that they should contribute one building to the Exhibition, and they have decided therefore to erect, on an admirable site on the shore of Lake Michigan, which was placed at their disposal by the Directors of the Exhibition, a building which might serve for offices and headquarters of the section. Colonel Edis, who has kindly accepted the office of hon. architect to the Commission, has furnished them with a design.

The building will be generally characteristic of the best type of English half timber houses of the 16th century, of which there are so many good examples still extant. It is proposed to use terra-cotta somewhat largely in the lower storey, with red brick facing and mullioned windows, so that the building may be a typical example of an old English house. The upper portion will be of half timber construction, with overhanging and projecting gables. As the building will be seen from all points, each façade has had to be treated architecturally. The plan forms three sides of a quadrangle with the open side next the lake, enclosed by a raised terrace with balustrade. The centre on the front or inland side will be recessed, with steps leading from both sides up the covered portico, which will open into a large central hall; off this will be, on one side, large library and reception rooms, and on the other, the secretary's office and the other rooms required for the work of the Commission. On the first floor will be a large suite of rooms and offices. It is intended to fit up all the principal rooms with wall panelling and elaborate ceilings, after the manner of some of the best English country houses. The whole of the internal fittings and furniture will be executed from Colonel Edis's designs by Messrs. Johnstone, Norman and Co., of New Bond-street. The foundations of the building have already been commenced, and the superstructure will be pushed forward with all speed, so as to be finished complete for the opening in May next.

Besides the necessary offices, the house will contain some large rooms, suitable for meetings of juries, receptions, &c., and the Commission hope that the accommodation thus provided may be found useful, not only for their own purposes, but for those of the various Colonial Commissions.

To assist them in their work, the Royal Commission have invited a number of gentlemen to act on various committees. A list of these will be found in the hand-book of regulations, published under the authority of the Commission. The most important of these committees is the one for the Fine Art Section, presided over by Sir Frederick Leighton, and in their hands have been left all the arrangements for securing what the Commission hope will be a representative gallery of British Art.

In accordance with the special request of the Chicago Executive, the Commission have also

appointed a Ladies' Committee to look after British contributions to the collection of women's work which is to form a prominent feature of the Exhibition.

At the outset of their proceedings an invitation was addressed by the Commission to all the Chambers of Commerce in the United Kingdom, asking whether they would act as Local Committees for the Exhibition. From many of these a favourable response was received; a list of them will also be found in the handbook above referred to. The local committee for Dublin consists of representatives of the Corporation of Dublin, the Royal Dublin Society, and the Chamber of Commerce. It is hoped that the exertions of this committee, supplementing those which were made before its formation by the Commission themselves in Ireland, will ensure a good representation of the principal Irish industries, and of this it is satisfactory to say there is every prospect.

In reply to the request addressed to the colonies through the Colonial Office, information has been received that the following colonies intend to be represented at Chicago:—Canada, New South Wales, Victoria, Tasmania, Cape Colony, Ceylon, Mauritius, British Guiana, Jamaica, Trinidad, Bermuda. Many of these have made large contributions, and have applied for a considerable amount of space.

The Commission regret that it still appears uncertain what part will be taken in the Exhibition by India. The India Office, after consultation with the Indian Government, declined to make any special grant, and in the absence of official encouragement, it appears improbable that any large or important contribution may be expected from India. A number of Indian manufacturers have, however, individually applied for space to exhibit their goods, and applications have also been received from several importers of Indian tea in this country, and from some Indian tea-growers on the spot.

As it is probable that a number of members of the Society of Arts may desire to visit Chicago during the time of the Exhibition, the Council have in view the making of special arrangements for their accommodation. They have already been informed that special facilities will be afforded to members of the Society of Arts visiting the Exhibition, and they hope later on to be able to announce that arrangements may be made for facilitating their journey to that city.

In addition to the contributions made by the exhibitors, the Commission have been promised various important exhibits, including a collection of educational apparatus from the London School Board; a collection illustrating the work of the Science and Art Department; a series of illustrations of the work produced by the Ordnance Survey; a similar series of the work of the Geological Survey; a collection of photographs showing the best work produced by English photographers, a collection of British minerals, a collection of metallurgical products, specially prepared for the section; a map illustrating the discoveries of Englishmen in North America, which is being kindly prepared by the Royal Geographical Society.

The Commission have issued, for the benefit of exhibitors and others, a "Handbook of Regulations and General Information." The handbook contains lists of the Commission, of the various Committees, and of the Colonial Commissioners, Synopsis of the Classification, General Regulations, Regulations of the British Section, Traffic Arrangements and Customs Regulations, description of the various Departments, Abstract of the McKinley Tariff Rates, Description of Chicago and the Exhibition, and account of the routes to the city. The information, which is presented in a concise form, will be valuable to all who contemplate a visit to Chicago. Copies of the handbook can be obtained on application to the Secretary.

XXI.—H.R.H. The Duke of Clarence and Avondale, K.G.

The late Duke of Clarence was elected a Vice-President of the Society of Arts in 1885, on the nomination of H.R.H. the Prince of Wales, President of the Society. The Council, feeling that a special loss had been suffered by the Society in consequence of his sudden death, felt it their duty to express to the President of the Society their sense of this feeling, and accordingly a memorial was addressed to His Royal Highness on the 18th January by the Council.*

XXII.—New Council.

The following are the Vice-Presidents who retire from the Council at the end of the Session:—The Attorney-General, M.P., Sir Francis Dillon Bell, C.B., K.C.M.G., Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., James Staats Forbes, Thomas Hawksley, F.R.S. To fill their places the Council

* See *Journal*, Jan. 22, 1892.

propose the following :—Sir Frederick Leighton, Bart., President of the Royal Academy, who has served before as a Vice-President of the Society, and who has for some time back taken an active part in the work of the Chicago Exhibition, in his capacity as President of the Fine Art Committee; Sir Villiers Lister, K.C.M.G, who retired by seniority a year ago, having served for a considerable period on the Council; Sir Albert Kaye Rollit, M.P., LL.D., Chairman of the London Chamber of Commerce; Mr. Michael Carteighe, President of the Pharmaceutical Society, Mr. C. M. Kennedy, C.B., and Mr. J. Biddulph Martin, who have occupied seats on the Council for some years past. Sir James Douglass and Mr. George Matthey retire from the Council by seniority.

To fill the five vacancies among the ordinary members of the Council, the following names are proposed:—Sir Edward Braddon, K.C.M.G., the Agent-General for Tasmania; Mr. Alfred Carpmael, who after serving since 1882, on the Council, retired by seniority last year; Sir George Hayter Chubb, whose experiences in exhibition work the Council think cannot fail to be of service to them; Mr. Walter Harris, who was sheriff of London in 1890; and Professor Le Neve Foster, the son of Mr. P. Le Neve Foster, for many years the well-known and much respected Secretary of the Society.

It will be noticed that amongst the names of the retiring members are those of The Attorney-General and Sir Philip Cunliffe-Owen. The Council felt it would be a serious loss to the Royal Commission for the Chicago Exhibition if they were deprived of the services of the Chairman, who had devoted so much of his time to the work since the Commission was appointed, and they were of course also anxious that they should not lose the benefit of Sir Philip Cunliffe-Owen's great experience in connection with Exhibitions, they therefore proposed to the general body of members at the special meeting summoned for the purpose on May 18, that a modification should be made in the bye-laws which would authorise them to add during the next two years six names to Council, either in the capacity of vice-presidents or ordinary members of the Council. The resolution proposed for the purpose was unanimously adopted, and the Council are therefore authorised to make the suggested additions to their number after the Annual Election is completed. They propose to add the names of the Attorney-General and Sir Philip Cunliffe-Owen, and also of some other gentlemen whose adhesion they think would strengthen the Council in its capacity as a Royal Commission for the Chicago Exhibition.

XXIII.—List of Members.

The total number of life members, subscribing members, and institutions in union which subscribe to the Society from their own funds is 3,310. During the year 1891-92, 324 members have been removed from the list by death or resignation. During the same period 282 have been elected.

XXIV.—Conversazione.

The Council have, by the permission of the Lords of the Committee of Council on Education, again arranged for the holding of the Conversazione at the South Kensington Museum. The meeting will take place this evening, and the arrangements to be made for the entertainment of the company have already been announced in the *Journal.*

XXV.—Obituary.

The Society has to deplore the loss by death during the past year of several eminent and active members. Two recipients of the Albert Medal — Sir George Airy, for many years Astronomer Royal, and Dr. A. W. Hofmann, the distinguished chemist—have also passed away during the year just ended. Dr. Alfred Carpenter and Dr. Tidy both read important papers on sanitary subjects before the Society, and the latter received in 1889 the Swiney Prize for his work on Legal Medicine. The Earl of Lichfield held the office of vice-president in 1871, and Sir James Brunlees was a member of Council in 1876. Mr. Mark Henry Blanchard, who was one of the earliest revivers of the use of terra-cotta, had been, at the time of his death, a member of the Society for nearly thirty years. Sir Francis Knowles, Bart., F.R.S., who died in March last at the great age of ninety, read a paper before the Society in 1873, on a "Method of Refining or Converting Cast Iron or Steel." Mr. Willoughby Smith, the eminent electrician, was a member for over twenty years, and Mr. Leonard Wyon, a member since 1852, had for many years struck all the Society's medals. The sudden death of Mr. P. W. Willans in the midst of his valuable labours, and at the early age of forty, gives cause for special regret. The Society has also lost the valuable services of Mr. William

Alexander Barrett, who had acted as the Examiner in Music since 1879.

Obituary notices of the above, and of some other members who died during the last twelve months, have appeared in the pages of the *Journal.*

XXVI.—FINANCE.

The Treasurers' annual statement of receipts and expenditure, which appeared in last week's *Journal*, in accordance with the Society's Bye-laws, shows a satisfactory state of the Finances. The amount received from members shows a slight increase, due to the Life Composition Fees, the amount from that source being £714, the largest sum received since 1862, when the Society had a great influx of members in consequence of its connection with the International Exhibition of that year. It will be seen that, although there is an increase in the number of candidates, the expense of the working of the Society's Examinations during the year has been covered by the fees received. A sum of £89 10s. has been received from a bequest by the late John P. Stocker, Esq. The Treasurers have been enabled to invest the sum of £1,378 in the purchase of Consols, retaining as large a balance as that with which they commenced last year. The excess of assets over liabilities is estimated at £17,771.

The CHAIRMAN moved the adoption of the report, and said that he felt sure the meeting would consider it thoroughly satisfactory as a record of the important work done by the Society, and of the valuable papers which had been read at the meetings during the past year. In allusion to the absence of the Secretary, he said he was sure that Sir Henry Wood was doing good work at Chicago, and that, in fact, they had evidence of this, as a cablegram had just been received from him to say that the question of pricing of goods by British exhibitors, which had given cause for anxiety, had been settled in every way satisfactorily.

The DUKE OF ABERCORN, Vice-President, seconded the motion for the adoption of the report.

Mr. WYATT PAPWORTH called attention to the terms of the offer of the Mulready and Stock prizes, and said that he did not think that the offer should be confined to students in the Schools of Art of the United Kingdom. He further thought that the Stock prize might with advantage be devoted to the encouragement of architectural design, and not merely to architectural decoration.

The CHAIRMAN said that the terms of the Mulready trust were that the offer should be confined to students in the schools of art, but that this was not the case with respect to the Stock prize; and he was sure that Council would give due consideration to Mr. Papworth's suggestion.

Mr. HYDE CLARKE said that he thought it very satisfactory that there had been so large a number of entries for the Spanish examinations. These were of special value, and it was found that a knowledge of the Spanish language was a most important acquirement among commercial men at the present time. With respect to Chinese, he thought perhaps an attempt to further a colloquial knowledge of that language would meet with success, as a knowledge of the language spoken at the commercial centres would be very valuable to members of mercantile firms. He supported Mr. Papworth's suggestion in respect to the Stock prize.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.
Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.
Duke of Abercorn, C.B.
William Anderson, M.Inst.C.E., D.C.L., F.R.S.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Sir Edward Birkbeck, Bart., M.P.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.
Michael Carteighe.
Lord Alfred S. Churchill.
Prof. James Dewar, M.A., LL.D., F.R.S.
Major-General J. F. D. Donnelly, C.B.
Sir Henry Doulton.
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
C. Malcolm Kennedy, C.B.
Sir Frederick Leighton, Bart., P.R.A.
Sir Villiers Lister, K.C.M.G.
J. Biddulph Martin.
General the Right Hon. Sir Henry F. Ponsonby, G.C.B.
Wyndham S. Portal.
Sir Robert Rawlinson, K.C.B.
Sir Albert Kaye Rollit, LL.D., M.P.

ORDINARY MEMBERS OF COUNCIL.

Sir Edward Braddon, K.C.M.G.	John Fletcher Moulton, Q.C., F.R.S.
Alfred Carpmael.	William Henry Preece, F.R.S.
Sir George Hayter Chubb.	Prof. William Chandler Roberts-Austen, C.B., F.R.S.
James Dredge.	Sir Saul Samuel, K.C.M.G., C.B.
Francis Elgar, LL.D.	
Prof. Clement Le Neve Foster, D.Sc., F.R.S.	
Walter H. Harris.	
Alex. B. W. Kennedy, F.R.S.	

TREASURERS.

B. Francis Cobb.	Sir Owen Roberts, M.A., D.C.L., F.S.A.

SECRETARY.

Sir Henry Trueman Wood, M.A.

The CHAIRMAN proposed a vote of thanks to the scrutineers, which was seconded by the DUKE OF ABERCORN, and carried.

The DUKE OF ABERCORN proposed a vote of thanks to the Chairman (Sir Frederick Bramwell), which was seconded by Mr. C. M. KENNEDY, and carried.

Sir FREDERICK BRAMWELL responded, and the meeting was then adjourned.

Miscellaneous.

ROYAL SOCIETY OF NEW SOUTH WALES.

Information has been received that the Royal Society of New South Wales offers its Medal and £25 for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon each of the following subjects:—

Series XI. (to be sent in not later than 1st May, 1892).—No. 37. "On the Iron Ore Deposits of New South Wales." No. 38. "On the Effect which Settlement in Australia has produced upon Indigenous Vegetation; especially the depasturing of sheep and cattle. No. 39. "On the Coals and Coal Measures of Australasia."

Series XII. (to be sent in not later than 1st May, 1893).—No. 40. "Upon the Weapons, Utensils, and Manufactures of the Aborigines of Australia and Tasmania." No. 41. "On the Effect of the Australian Climate upon the Physical Development of the Australian-born Population." No. 42. "On the Injuries occasioned by Insect Pests upon Introduced Trees."

Series XIII. (to be sent in not later than 1st May, 1894).—No. 43. "On the Timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes." No. 44. "On the Raised Sea-beaches and Kitchen Middens on the Coast of New South Wales." No. 45. "On the Aboriginal Rock Carvings and Paintings of New South Wales."

The competition is in no way confined to members of the Society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way. The communication, to be successful, must be either wholly or in part the result of original observation or research on the part of the contributor.

The Society is fully sensible that the money value of the prize will not repay an investigator for the expenditure of his time and labour, but it is hoped that the honour will be regarded as a sufficient inducement and reward.

The successful papers will be published in the Society's annual volume. Fifty reprint copies will be furnished to the author free of expense.

Competitors are requested to write upon foolscap paper—on one side only. A motto must be used instead of the writer's name, and each paper must be accompanied by a sealed envelope bearing the motto outside, and containing the writer's name and address inside.

All communications to be addressed to the Honorary Secretaries, the Society's House, 5, Elizabeth-street, Sydney.

Correspondence.

BRITISH SHIPBUILDERS AND THE CHICAGO EXHIBITION.

From a report made to me by Commander Hoff, who has been visiting the Clyde and other shipbuilding centres, I am afraid that the firms do not thoroughly understand the advantages that might accrue to them from exhibiting at Chicago. I should, therefore, be pleased if the following facts can be brought under their notice:—

The recent Act of the American Congress, permitting citizens of the United States steamship companies of the United States to purchase one steamship abroad for everyone they build at home, is of greater importance to the British shipbuilder than any public Act in any country for half a century. It means that one-half of the steamships required in the United States for its growing trade may be purchased abroad. By special Act of Congress, four ships of British build, which have hitherto sailed under the British flag have been transferred to that of the United States; the *China* and *Foxall*

besides the well known cases of the *City of Paris* and the *City of New York*. This is practically a sale of four British built ships to American lines, and but the forerunner of a large business if the British ship builder is alive to the opportunity now held out to him.

The increased demand for freight carriers of the highest class and speed is evidenced by the growth in the business of one line, that of the Brazilian Steamship Company, which plies between New York and Rio. I repeat here, for emphasis, what I have said before on several occasions, that whereas less than one year ago the company above referred to found that one or, at the outside, two steamers per month were quite sufficient for freight offered, that company now employs fifteen steamers per month, of which thirteen sail under the British flag. The number employed is limited rather by the difficulty of securing ships than by the trade, which has grown so rapidly of late. Should circumstances require an increase in this number, the disposition will be rather to purchase new ships with all the modern improvements — which mean small coal consumption and lower running expenses—than to take any old ships which are lying in the docks, not only on account of the falling off in British trade, but also on account of their not being up to modern requirements.

The ship-yards of the United States have orders ahead which will keep them busy for some years, which in itself will make it impossible to meet increasing demand from these yards, so that for every two new ships constructed one must be ordered from foreign ship-yards. I need only refer to the increase in the demand which the construction of the Nicaragua Canal will bring about. The Republican and Democratic Conventions, recently held at Minneapolis and Chicago respectively, endorsed the proposition for Government aid to this canal, which assures its construction in the near future.

If the growth of trade on the Pacific coast of South America is at all comparable with the eastern coast, prominently with Brazil, the demand for ships for this trade will open a market for the British shipbuilder that in his most sanguine moments he has not looked forward to. Our own shipyards will be kept busy providing steamers for our own coastwise and inland trade, so that it is safe to say that the British shipbuilder will have a chance of competing with German and French shipbuilders to construct one-half of the new ships which the United States will require.

The German Government is interesting itself in this subject, and the ship building interest of Germany, though in its infancy as compared to Great Britain, will be represented in every detail.

The British ship builder may feel that he has nothing to fear from either France or Germany. There may seem little ground for such fear at this time, as there was little ground some years ago that the iron and steel industries of Great Britain had anything to fear from European competition. It is worthy of note in this connection, that while the export of iron and steel manufactures from Great Britain fell off 21 per cent. for the year 1891 as compared with the year 1890, the exports of iron and steel manufactures from Germany increased 19 per cent.

The manufacturers in every industry can well learn a lesson from these figures, and should be aroused by them to at least investigate the cause for this transfer of trade from British to German workshops.

ROBERT S. MCCORMICK.

72, Victoria-street,
June 28th, 1892.

General Notes.

BLACK HOLE OF CALCUTTA.—An account of a visit made to the newly-discovered site of the Black Hole of Calcutta was given in the *Englishman* (Calcutta) of 24th March. A number of photographic copies of an old plan of old Fort William, made by Lieutenant Will, or Wells, in 1753, were distributed to many of those present. Mr. C. R. Wilson, in the first instance, led the party to the excavations in the post-office compound, showing the position of the south curtain wall, and also the position of a small wall jutting off from this curtain wall on its south side. This wall, it was explained, was a boundary of the warehouses built against the south curtain in the year 1747. It was pointed out that these walls agreed with the plan of 1753, and that the old arcade within the post-office compound was a portion of the south side of the old fort. The party were next shown an excavation at the east gate of the post-office, showing, first, the east curtain wall; secondly, the wall containing the rooms built against the east curtain, which stopped here; thirdly, the corner where the foundation walls of the columns of the verandah along the east side of the fort met the foundation wall of the third line of arches along the south side of the fort. On comparison, it was clearly shown that these walls agreed with the plan of 1753, that the foot of the stairs, to the south-east bastion, came where the pavement marking the reputed site of the Black Hole now was, and that the real site of the Black Hole was immediately to the north of this pavement. In reference to this, Mr. Wilson added that Sir Charles Elliott was going to remove the pavement which was supposed to mark the site of the Black Hole, and place it where he (Mr. Wilson) had shown it ought to be placed.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 6th inst. Present: Sir Frederick Abel, K.C.B., F.R.S., in the chair; Alfred Carpmael, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., James Dredge, John Biddulph Martin, Sir Owen Roberts, M.A.

COLLECTION OF GUIDE BOOKS, &c.

The Royal Commission are forming a collection of Maps, Guide Books, Photographs, Railway and Steamship Guides, Programmes, &c., and other printed matter likely to supply useful information to exhibitors at, and visitors to the Chicago Exhibition.

The collection is placed in the library of the Society of Arts for consultation by persons interested. It will be open to members of the Society, exhibitors, or their agents, and persons introduced by either of the above.

A considerable number of books, &c., have been collected, but the Royal Commission will be glad to receive any works suitable for the above purpose for addition to the Collection.

HANDBOOK OF REGULATIONS.

A "Handbook of Regulations and General Information" connected with the Royal Commission has been printed, and can be had on application to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi. The Handbook contains lists of the Commission, of the various Committees, and of the Colonial Commissioners, Synopsis of the Classification, General Regulations, Regulations of the British Section, Traffic Arrangements and Customs Regulations, descriptions of the various Departments, Abstract of the McKinley Tariff Rates, description of Chicago and the Exhibition, and account of the routes to the city.

PREVENTION AND EXTINCTION OF FIRE IN THEATRES.*

By Ernest A. E. Woodrow, A.R.I.B.A.

When, in 1883, the Society of Arts offered the Society's Gold Medal for the Fothergill Prize, I submitted to the Council a paper upon "The Prevention and Extinction of Fires in Theatres," and although the Council did not consider that my paper came within the terms of the prize, they had it printed in the *Journal* of the Society in April, 1884. It is evident that the Council deem this subject one of the greatest importance, as they again offer the Gold Medal for the Prevention and Extinction of Fires in Theatres. Although the views I expressed eight years ago are still on record in the Society's *Journal*, I will venture, even at the risk of repetition, to lay before the Council what I consider are the leading points to be observed on this subject, which is undoubtedly one of the greatest moment to the community at large. For this reason I may crave indulgence, after the lapse of time, in again drawing the attention of the Society to the construction of a theatre in relation to the prevention and extinction of fire.

The result of the competition for the medal in 1883 showed that the Council had no invention submitted to them which they considered would either prevent or extinguish fire in theatres. I endeavoured, at that time, to show how prevention and extinction of fires in this class of building depended entirely upon good building, good planning, and good fire appliances, not upon inventions; the same remedies of prevention also apply to panic—the outcome of fire. These views have been endorsed again, and but lately, by the greatest authority upon the subject, Captain Sir Eyre M. Shaw. Writing in one of the Reviews he remarks: "If a theatre is built on sound principles, suitably

* This paper was submitted to the Society in competition for the Fothergill Prize. The Council were of opinion that the essay did not come within the terms of the offer of the prize, but they decided that it should be printed in the *Journal* [see *ante* p. 673, Report of Committee on Fothergill Prize, and p. 776, Report of Council]. A former paper by Mr. Woodrow, on the same subject, was printed in the *Journal* in 1884 [see vol. xxxii., p. 350].

provided with fire-extinguishing appliances, and well managed, a panic does not cause loss of life; and this is not the only 'law' that may be evolved out of the evidence which is now available."

One cannot separate the consideration of the prevention of fires from that of the prevention of panic, for were fire not attended with the awful results of panic, the importance of this subject would be but small, in fact, it would be reduced to the simple question of the protection of property and vested interest; and, under such circumstances, I should not feel justified in presenting this paper to the Council. It will be remembered that in the report of the committee appointed by this Society, in 1883, to consider the prevention of fires in theatres, reference was made to the fact that, in the case of the Vienna Ring Theatre fire, many corpses were found seated in their places, sudden death from asphyxia having prevented any effort to use the means of escape.

It is far from my wish to deprecate the advantages of appliances and inventions to minimise the risk of fire; but what I wish to assert is, that a badly built, badly planned theatre, even when fitted with all the latest and most approved appliances, would not be a "safe" theatre, nor one in which the prevention and extinction of fire could be depended upon with any degree of certainty. Now, in a house where every detail of construction and planning has been observed, the simplest means will extinguish fire, and its construction prevent the fire spreading from one portion of the building to another. It is a case of the thoughtful study of detail, observation of the causes of fires in the past (small as well as great), and making provisions against the probability of recurrence: "The laws that may be evolved out of the evidence," as Captain Sir Eyre M. Shaw so aptly puts it. If we build according to these "laws," fire and panic in theatres will be reduced to a minimum, and even where fire does occur, panic will be averted.

In passing, may I be permitted to draw attention to a newspaper report of recent date: the circumstance therein described is trivial in itself, but sufficient to use as an illustration to show that by the observation of details provisions can be made to minimise the chances of fire; I have really chosen this example on account of its seeming unimportance, and to show that it is only by experience the difficulties of theatre planning can be overcome.

The *Globe* of 5th of last October reported an alarm of fire in a theatre, and stated that the "fire occurred in a dust-hole;" now it is well known how inflammable the refuse from a theatre is, composed as it is of shavings, papers, dust, and such like dry rubbish. In the list of the probable causes of fire, given by me in my paper in the Society's *Journal* will be found mentioned, "Darkness and dirt and keeping rubbish shavings, &c., on the premises." The "law" or lesson to be evolved from this circumstance is that "dust holes" in theatres are a source of danger, and the abolition of them a preventative of fire, also that rubbish should not be collected in a theatre but be removed daily; again, that trade refuse is a cause of danger from fire to a theatre, and that therefore the carrying out of trades in the house is a practice that should not be permitted. Every disaster, small or great, teaches a fresh lesson. The summing up of all this is, that a theatre should be so planned that such evils would be quite impossible. I could quote other instances of causes of fire equally trivial in themselves, which, but for their early extinction, would be disastrous in their results, and from which other instructions could be gathered. The above is, however, sufficient for my present purpose to prove that safety in theatres depends upon starting on the sound basis of a good honest study of every detail of theatrical business, ascertaining what risks attend each department, and making provisions to overcome the danger.

I shall endeavour to touch upon some of the most important points to be observed in theatre building; having the object of the prevention and extinction of fire in view, I shall not enter minutely into the details that I did in 1883, and I do not propose to accompany this paper with diagrams, although those I presented to the Council in 1883 would apply equally well to illustrate these remarks. In bringing the subject again before the Council, I shall be compelled to traverse much of the same ground, for I do not feel that I shall be justified in allowing this opportunity to pass without protesting against the false security likely to arise through placing good inventions in a badly built and planned house. I hope, indeed, to be able to strengthen my case by the additional years of experience gained since last I addressed the Council. One word as to extinction of fire before entering into details. I have failed, during the past eight years, to see

any reason to alter my opinion that, to extinguish fire, there can be no more efficient means than — given an ample water supply, a good fire watch.

Choice of Site as a Prevention of Fire.

Many theatres may, in themselves, be reasonably safe from fire; they may indeed be provided with the most efficient means of extinguishing fire, and yet, from their very position, they may be in constant danger—in danger from the adjacent and surrounding neighbouring premises. Again referring to recent newspaper reports, it was but a short time since that one of the London theatres was placed in an alarming position, through a fire in a neighbouring house; panic was averted through the timely interference of good management, and the house was cleared without mishap.

In glancing over the regulations enforced in foreign countries with regard to the site upon which a theatre should be built, the rules, we find, are far more stringent upon the Continent than in our own country. In Austria, new theatres must be erected perfectly isolated, and not less than 49 feet distant from the boundary of the land on which they stand. This seems a severe measure, but it is to prevent the spread of fire from other premises, as well as to allow ample means of exit. Small theatres in Austria may have the back wall of the stage abutting on other houses, but the other sides must be free.

In St. Petersburg all theatres must have an open space upon every side. In Brussels every theatre must be separated from adjoining premises by an open space or thick brick wall; when the open space is less than 10 ft. 6 in. there must be no window overlooking it belonging to adjacent premises.

People who invest their money in theatrical undertakings in our country, assert that the imposition of such regulations as these would render theatrical enterprise in this land impossible, as the price of land in the locality where theatres pay would prohibit the erection of such places of entertainment on isolated sites. It is true that it has been proved by experience, that the circle within which to build paying theatres is but small, the land dear, and the opportunities of acquiring suitable sites few and far between; in fact, it is only when street improvements take place that opportunities arise to afford plots of land of such merit as the one occupied by the Royal English Opera-house.

Not only is an isolated site a desideratum for preventing fire, but it is also requisite for extinguishing fire, as a building surrounded by wide streets is easily accessible to the fire brigade engines and escapes. It is unnecessary here to add the arguments in favour of perfect isolation with regard to satisfactory exits and the prevention of panic; and it is also unnecessary to consider what, if any, curtailment of this requirement may be made with safety.

In countries, however, where State aid is not obtainable, such rigid rules as those framed in continental cities have been found to be impracticable. The most recent laws with regard to theatre sites are those of the London County Council and New York City, both framed in 1892; these I quote in full:—

London County Council.

"One-half at least of the total length of the boundaries of the site of any such premises which consist of an entire building, and in case of a room or other such premises not consisting of an entire building, one-half at least of the total length of the boundaries of the site of the building of which such room or other such premises form part, shall abut upon public thoroughfares, of which one thoroughfare at least shall be not less than 40 feet wide, and of the remainder none shall be less than 30 feet wide if a carriageway, or 20 feet wide if a footway.

"If, in compliance with Regulation No. 10, an additional passage or way should be necessary, it may be provided by means of a private passage or way.

"Such passage or way shall not be less than 10 feet in width, and under the complete control of the owner of such premises, and no doors windows, or other openings of the adjoining premises shall communicate therewith, or overlook any portion of such passage or way.

"Two separate exits, not leading into the same thoroughfare or way, shall be provided to every tier or floor of such premises.

"If any tier or floor shall be divided into two parts, two separate exits, not leading into the same thoroughfare or way, shall be provided to each of such parts."

Such exits shall be so arranged as to afford a ready means of egress from both sides of each tier or floor, and should lead directly into a thoroughfare or way.

"*New York City Building Laws.*

"Every such building shall have at least one front on the street, and in such front there shall be suitable means of entrance and exit for the audience. In addition to the aforesaid entrance and exit on the street, there shall be reserved for service, in case of

an emergency, an open court or space on the side not bordering on the street, where said building is ocated on a corner lot, and on both sides of said building, where there is but one frontage on the street. The width of such open court or courts shall be not less than 7 feet, when the seating capacity is not over 1,000 people; above 1,000, and not more than 1,800 people, 8 feet in width; and above 1,800 people, 10 feet in width.

"Said open court or courts shall begin on a line with or near the proscenium wall, and shall extend the length of the auditorium proper, to or near the wall separating the same from the entrance lobby or vestibule. A separate and distinct corridor shall continue to the street from each open court, through such superstructure as may be built on the street side of the auditorium, with continuous walls of brick or fireproof materials on each side the entire length of said corridor or corridors, and the ceiling and floors shall be fire-proof. Said corridor or corridors shall not be reduced in width to more than three feet less than the width of the open court or courts, and there shall be no projection in the same; the outer openings to be provided with doors or gates openings towards the street."

With regard to sites where neighbouring premises have doors or windows overlooking openings in the theatre, provision should be made to protect the windows in the theatres by iron hoppers, and the doors by sheet-iron linings. This precaution is to prevent the spread of fire from adjoining houses.

The Height of a Theatre as a Protection from Fire.

The restriction of the limit of the height of a theatre is next in importance to the surroundings, in reducing the fire risk and assisting fire extinction.

The majority of theatres that have been built within the last few years have been so planned as to place part of the structure below the level of the street. Limit should certainly be placed upon the depth to which the lowest part of a theatre should be situated below the pavement; with this desired limit, the system recommends itself as a good one, as it greatly curtails the height of the building, and also places the occupants of the various levels at more equalised distances from the street.

The Savoy Theatre may be quoted as a good example of this system; but a few steps lead to the pit, the dress circle is on a level with the street, the upper circle but a step or two above the pavement, and the gallery is approached by a very short staircase, as gallery staircases go.

For present consideration it may be asserted that a limit in height, obtained by placing the pit below the level of the street is a distinct advantage in preventing and extinguishing fire. There should, for the same reasons, be a restriction on the number of tiers, and this is insisted upon at St. Petersburg, where theatres must not contain more than four tiers in addition to the pit. In Italy the tiers are only permitted to be three in number.

The Division of a Theatre into parts by Brick Walls as a Preventative of Fire.

To prevent the spread of fire from one part of the building to another may almost be considered more important than provisions for extinguishing fire. The most perfect arrangements for extinguishing fire would be of far less use in a building constructed entirely in one risk, than in one divided into several fire risks by sound brick walls and solid fireproof floors.

A theatre ought to be so constructed that should a fire occur in any one part, the fire would burn itself out in that part, and not spread to other sections of the house. The following is what I consider is the most effective means of obtaining this condition of affairs. A theatre may be divided into four parts—(1) the workshops, (2) the stage, (3) the auditorium, (4) the approaches, which may again be subdivided into several parts, as rooms or shops for the various trades appertaining to theatrical business, scene docks, property rooms, the stage with its cellar, mezzanine, flies, gridiron, the auditorium with its tiers of boxes, galleries, corridors, passages, vestibules, saloons, cloak-rooms, &c., —it is useless here to try and complete the list.

Each of the larger divisions should be contained in solid brick party walls, passing through and above the roof, with as few openings in the walls as possible, and such openings should be closed and protected by doors, shutters, or curtains of fire-resisting materials.

Each of the sub-divisions should be constructed with brick walls, with floors and ceilings of concrete, in the case of the stage; only the floor of the stage need of necessity be of wood, the whole of the gridiron and flies could be constructed of iron. Much of the machinery at present made of wood could be of iron, and, in fact, be better adapted for the purposes of scenic display. The ropes for taking on and off the sliders could be made of steel.

The total separation of the workshops in

which the trades are carried on is most essential for the safety of a theatre, and such separation would in nowise interfere with the working of the house. Where large quantities of scenery are stored, they should be placed in a building quite apart from the theatre, but where the scenery that is in constant use is kept, the docks should be separated from the stage by brick walls, with openings closed by iron doors. The scenery in nightly use may be shifted into scene docks at the side or behind the stage. These scene docks, however, should not be used as permanent stores, but only for placing the scenery in, when shifting from one scene to another during the evening's performance. The same argument applies to property rooms.

The erection of a "proper brick proscenium wall," to divide the auditorium from the stage, has become a recognised necessity in theatrical buildings. The wall must pass through the roof, and be carried down to the level of the footings of the main buildings, in fact, be as substantial as an outside wall, with the large opening left for the proscenium. The wall must also pass under the stage, to divide the mezzanine of the stage from the orchestra. In addition to the large, or proscenium opening, there should be as few openings as possible in this wall. One is usually found at the stage level leading into the auditorium, and one beneath the stage leading into the orchestra. A theatre could be designed obviating even the necessity for these. Where openings do exist, they should be closed by self-closing doors of fire-resisting materials. The separation of the stage from the auditorium by a brick wall, with the smaller openings protected, but the large or proscenium opening left without fire-resisting curtain or shutter, would appear, even to the uninitiated, but taking half-measures for the prevention of spread of fire. The addition of a curtain, made of a material to check, if only for a time, the passage of smoke and flame from the stage to the auditorium, is undoubtedly a necessary provision in theatrical architecture.

Opinions differ greatly as to the nature of the material that should be employed for this curtain to fill the proscenium opening. The material must be such as to prevent or retard the passage of smoke or flame; one that will not feel the effect of the sudden changes of temperature from fire and water, and one that will resist the contact of falling bodies, such as timbers, scenery, &c. Iron will retard the passage of smoke, and for a certain time will keep back the spread of fire; but it will not withstand sudden changes of temperature. Wire-gauze curtains will not withstand the force of falling bodies. Certain forms of asbestos curtains will not bear their own weight, and become easily torn. Water and canvas curtains depend entirely upon the presence of the water to make them effectual for even a short period, and water curtains allow the passage of smoke. A curtain which appears to meet all requirements has been invented, the construction of which is described as follows:—"The protected iron curtains in an open framework of iron on wire, which is protected with a covering of silicate cotton, or slag wool, on each side; this silicate cotton is covered with wire netting, and forms an absolutely non-conducting material, and can be covered on the auditorium side with green baize, and so take the place of the old-established 'Green Curtain, or have painted canvas, and take the place of the 'Act drop.' The whole curtain is sufficiently pliable to adapt itself to any strain, and yet be perfectly fire and smoke proof. It can be raised by man power, by hydraulic power, by pneumatic pressure, or by other means found convenient. If desired, it can be lowered from any number of given points inside or outside the theatre." Other forms of curtain of equal merit exist, the detailed description of which is not wanted to increase my argument as to the need of such a provision.

The absolute necessity of the constant use of the fire curtain at every performance is obvious, in order that the lowering of the curtain may cause no feeling of alarm among the audience as well as to ensure the working order of the apparatus.

It is greatly to be wondered at that, for the prevention of the spread of fire in theatres, fire-resisting proscenium curtains were not insisted upon in London until the present year. In Paris a curtain of wire gauze must be provided to every theatre, the curtain must be hung with combustible cords and counter weights, suspended by metallic ropes, to check the rapidity of the descent. In Brussels and Hamburg metal curtains are insisted upon, and in St. Petersburgh a curtain of the required qualities has to be provided.

At first sight it would not appear that the size and proportions of the stage could have anything to do in minimising the risk from

fire, but in order to allow the scenery to be lifted up bodily, or to be moved off to either side of the stage, without being folded or rolled, the height from the stage floor to the gridiron should be twice the height of the proscenium opening, and the width of the stage from side wall to side wall, should be double that of the proscenium opening. By this provision the great risk of the canvas coming into contact with the hanging lights of the stage is avoided.

The introduction of the electric light on the stage has reduced this evil. Its use should be insisted upon as it is in Madrid. A very great risk from fire on the stage is thus prevented by the use of the electric light in lieu of gas for the purposes of illuminating the scenery; the danger arising from the gas among the canvas was the greatest that had to be contended against. Many theatres, however, are still lit by gas, The precautions of fireproof construction we have considered must not be overlooked because of the advantages of the electric light.

Having now considered the greatest divisions of a theatre with reference to the prevention of fire, it is necessary to pass on to the sub-divisions with the same object in view. In my former paper I dwelt upon the desirability of the provision of ample exits, the position in which they should be placed, the number of people that should use each exit, and such like details for the prevention of panic. I do not again propose to enter into this important branch of the subject.

The construction of the exit and entrance corridors, passage ways, and staircases should be entirely of fireproof materials, enclosed in, and supported upon solid brick walls, with floors and ceilings of portland cement concrete. A corridor of ample width should run round the back of each tier, divided from the auditorium by good brick walls, with means for closing the openings with either stout oak protected wooden or iron doors. By this precaution the audience would find a refuge immediately at the back of their seats, and the spread of fire from the auditorium to the exits would be retarded.

The construction of the tiers and galleries of most of our theatres erected within the past few years has shown great advancement towards perfecting theatre buildings. The cantalever system, and abolition of iron column supports to the various tiers, has a dual advantage, and the first that naturally asserts itself to the playgoer is the sighting of the house, the second and by far the most important is the additional fire-resisting qualities of the construction of the house under this system.

Until within quite recent times the tiers of the auditorium were universally constructed entirely of wood, with raking wooden stages supported upon unprotected iron columns. Where fire occurred, the columns gave way, and the falling timbers added fuel to the flames.

Tiers constructed on the cantalever system have no columns to collapse, but depend for their support entirely upon steel girders, and cantalevers embedded in concrete and supported by brickwork; upon this the "risers," or rows of seats, are built up, in concrete and iron, there is therefore nothing to burn.

The best kind of steps for staircases is one made of concrete faced with a hard wooden tread securely fastened to the face of the step. The steps should be "solid square" as distinguished from "spandril;" they should be cast with a light girder or rolled iron joist embedded in their length, to prevent fracture; the steps should be built into and supported by brick walls at both ends. Stone has been proved no fit material for the resistance of the flames, or the sudden changes of temperature caused by fire and water. It cracks under the influence of fire, and in cases of staircases, breaks short off where the steps are of "spandril" shape and supported only at one end. It is known that iron is also a material of little value in resisting fire; many examples of the manner in which it twists and collapses from the action of fire, are to be seen after fires in warehouses where floors are supported by columns and girders of unprotected iron.

Not only does the failure of iron to withstand the action of fire and water prohibit its use in an unprotected state, but also the fact that with its failure and collapse, other materials and the superstructure give way also. Iron must therefore be encased in some fire protecting substance, such as plaster, terra-cotta, or concrete, so as to prevent the direct action of fire and water upon it. Under these conditions iron is an acceptable agent in theatre construction.

Wooden beams, if used in great thickness and protected by plaster, would be quite admissible in theatre construction as far as fire-resisting qualities go; but their bulkiness would prohibit their use in modern buildings of this class. Heavy wooden girders have frequently been only charred in fires where naked iron girders and columns have entirely given way.

The roofs of theatres should be constructed of fireproof materials, to prevent fire spreading from any neighbouring building over-topping the theatre. For the same reason skylights should be covered on the outside with strong galvanised iron wire guards. In isolated buildings, the danger of spread of fire through the roof from surrounding property is abolished.

Living rooms should never be allowed in a theatre. The ordinary danger of fire arising from a domestic house is thereby added to the risks already existing.

In furnishing a theatre, due regard should be given to the one great object in view—not to add fuel to the flames. It is not necessary to detail here the furniture and fittings of a theatre that could be made of uninflammable materials, but one may mention, as examples, that frames of seats should be of iron, that plaster should be used, instead of wood, for decorative enrichments, and that the lighter fabrics should be periodically steeped in a fire-resisting solution. It is not so long ago that the internal fittings of a theatre were wooden partitions, matchboarded divisions, canvas screens, and such like inflammable construction.

Where light partitions or divisions are necessary, such as the separation of private boxes, these partitions should be formed of fire-resisting plaster upon iron frames and wire lathing.

Ventilation as a Preventative of Fire.

Perfect ventilation is admitted by all to be of the greatest importance in buildings of public entertainment, for the health and comfort of the audience, but I do not think it is often looked upon as a desideratum for the prevention of fire; yet, my experience teaches me that a well-ventilated theatre, with windows admitting plenty of daylight, is less likely to catch fire than a dark, stuffy house. Many bodies, when kept cool, are incombustible, but when constantly subjected to a high temperature, become highly inflammable; more especially is this apparent in that portion of a theatre called the dome—that is, the space over the auditorium ceiling, which used, at one time, to be the favourite position for the carpenter's shop. When this part of the house was built of wood, the timber, in time, became little better than tinder, ready to flare up on contact with the slightest spark. The same state of affairs was frequently to be found in the gridiron, and among the roof trusses over the stage; here, where no ventilation or light was admitted, dry dust collected, and the excessive heat from the hundreds of lights of the stage below, which gathered among the timbers, created a condition of things terrible to contemplate.

Advancement in the science of building has prevented the probability of fires in the roof of a theatre, the space over the "dome" is seldom used, and concrete roofs and ceilings, proscenium walls, ventilation and daylight, have reduced the risk to a minimum.

Efficient ventilation, constantly changing the air, to keep the house at an even temperature, is what must be acquired. The ventilation of the stage requires great care. There must be no down draughts to move about the flats, cloths, or wings among the gas battens and side lights; the system must be one of extraction at a high level, and admission at a low level. By ample ventilation the danger of asphyxia in cases of fire is guarded against.

Daylight and cleanliness, I have said, are essential for the prevention of fire. Where ample daylight is admitted, there is every chance of the theatre being swept and kept clean in every corner; collections of rubbish, dirt, and dust, in out-of-the-way nooks and corners, are always a source of danger. Dry dust, paper, shavings, oil-rags, and such like inflammable refuse, ready to ignite by spark or spontaneous combustion, are often found swept away out of sight by the cleaners. Such carelessness and thoughtlessness are too often the cause of fire. The use of matches, the burning ends of cigars or cigarettes, recklessly thrown among those dangerous little heaps of rubbish, is sufficient to start a fire which may end in dreadful results and loss of life. Carelessness among the scene-shifters, the gasmen, the electric light men, on the stage, in the dressing-rooms, or workshops, must be ever guarded against. The use of firearms, fireworks, and coloured fires should be carefully watched by the fireman in charge. The upsetting of oil-lamps, explosion of limelight bags, the existence of foul gas burners, are all sources of danger. Among other causes of fire to which a theatre is subject, I cannot speak too strongly of the great danger of carrying on various trades in a theatre, or in workshops in the same risk as the theatre. I have already said that the structural separation should be strong party-walls and fireproof floors, and the reasons for this are not far to seek. The trades appertaining to a theatre necessitate the employment of light and highly inflammable materials. The stage carpenters' work is of

a thin and flimsy character; the property-makers' "props" are mostly of wood and paper; the wardrobe-makers' stores are fitted with highly inflammable substances; the scene-painters' room contains little but combustible materials, and the scene docks are crammed full of flats, scenery, cloths, and "props," as dry as tinder. The engine-room, electric light shed, dynamo room and furnace chamber are all adjuncts of the modern theatre, which, if not separated from the theatre, add greatly to the risks of fire.

The importance of placing all trades in rooms specially built for the purpose requires no further explanation, when the prevention and extinction of fire is under consideration. It is not necessary now to speak in much detail of causes of fire arising from defective gas servive, or electric light supply; suffice it to say that gas meters should be placed in proper brick ventilated, brick built chambers, with a ceiling of concrete and the opening closed by an iron door, and that gas brackets should not be jointed, nor pendants of a telescope pattern. Gas pipes must be of hard metal, the sun burner and fitting constantly cleaned, and a proper gas plate provided on the "prompt" side of the stage.

The special system of warming theatres requires most careful study. The authorities of different countries insist upon different methods of warming public buildings. Paris demands that no theatre may be warmed except by air gratings, the furnaces for which must be placed in the basement. Brussels leaves the system open to choice, but compels the apparatus to be non-explosive, and placed in a vault separated from the rest of the building by double doors. In London the furnace room must be in a separate building, entered directly from the street, with a large open grille for the escape of steam. In St. Petersburg, the only method to be employed is steam or hot water, and, in Berlin, where hot air is enforced, the gratings must be protected by wire netting of close mesh, and no objects of an inflammable nature are allowed near the grating. Where hot air is used, the conduits must be constructed of iron or of earthenware, 2½ inches thick, including the coating. Where hot water is the heating power, the apparatus should be of the low-pressure system.

Open fireplaces are objectionable in most parts of a theatre, but where they are necessary, they should be protected by fixed iron wire-guards, with a door left to open for the purposes of cleaning the grate. On no account should open fireplaces be allowed in any part of the stage, workshops, scene docks, or stores. Where closed stoves are used, they should be earthenware. Stores should not be heated at all.

Special care must be given to the building of the flues and chimney stacks, which should be kept clean and periodically swept.

At the risk of again repeating myself, I will now enumerate some of the causes of theatre fires, with the object of making provision to prevent fires in theatres.

1. Not dividing the various sections and sub-sections by proper brick walls and fireproof floor and ceilings.
2. The use of inappropriate building materials.
3. Bad, faulty, or scamped construction.
4. Inflammable fittings, finishings, and furniture.
5. Dangers arising from the proximity of surrounding premises.
6. The misuse of portions of the premises; living on the premises.
7. Dirt and darkness, non-removal of trade refuse.
8. Excessive heat and want of proper ventilation.
9. Open and unprotected fire-places, faulty flues.
10. Imperfect gas system, faulty installation of electric light.
11. Use of matches, naked lights, spirit lamps.
12. Imperfect warming apparatus,
13. Smoking in parts of the theatre not specially adapted and fitted for the purpose.
14. Lighting, spontaneous combustion, incendiarism.
15. Want of proper fire appliances.

To extinguish fires in theatres there is only one practical and reliable system. The proper use of water in conjunction with proper fire appliances. One of the most effective fire appliances is the common fire-bucket. These should be hung in large numbers in all parts of the theatre, on the walls just above the heads of the audience. They should be filled with water at all times, a bucket of water judiciously used at the outbreak of fire will save thousands of pounds' worth of property, and perhaps hundreds of lives.

If the fire is not discovered in its first stages, the water must be played upon it with some degree of force. Then the various forms of portable engines, corridor engines, hand-

pumps, chemical engines, extincteurs, &c., are necessary. When the fire attains serious proportions, the hydrants must be brought into play, and be followed by the brigade engine and the brigade. Provision for all these appliances must therefore be made in all sections of the house, with all fittings, tools, &c., required by a fireman. The employment of trained firemen, as constant day and night watchmen, is the duty of every manager having the safety of the public in his hands. It should be the duty of these men to attend to all the appliances and the fire curtain, and to turn off the gas from the main at the outbreak of fire; a provision of safety which calls for the subsidiary lighting of the passages, staircases, and corridors by oil lamps, or composite candle lamps.

On the stage should be kept wet blankets, hatchets, axes, reaping hooks, to cut away the scenery.

The materials used upon the stage should all be periodically saturated and coated with such substances as would impart fire-resisting qualities.

One word as to water supply. Tanks are not to be relied upon, they are too often empty or only half full when most needed. The water supply to the hydrants should be on the high pressure constant supply, and be obtained direct from the main.

The theatre should be in telegraphic and telephonic communication with the nearest fire brigade station, and outside balconies with escape ladders should be provided to all parts of the theatre, as means of escape and for the use of the firemen.

In writing the above I have not lost sight of the desire of the Council of the Society of Arts to obtain an invention for the prevention and extinction of fire, but, with a somewhat wide experience of theatre construction before me, it has been my earnest desire to lay before the Council the many risks in and about a theatre with which no invention would effectually cope, unless assisted by a judiciously planned and well-built house situated on a suitable site, and well managed. Such inventions for extinguishing fire as require the very presence of the enemy to start them into action cannot be too strongly condemned; water sprays and sprinklers set into action by the melting of solder may start, through excessive heat, when not required, and will do more harm than good, and perhaps cause alarm and panic. Everything in a theatre, to be effectual, must be in constant use. The employment of sprinklers over the stage, on the non-automatic system, is undoubtedly an advantage, as by them the whole of the scenery can be instantly wetted. It is thought by some that the fitting up of patent appliances and inventions in old and ill-constructed theatres will render them safe, but to the initiated the fallacy of this is apparent. Such appliances are good servants, but they will never become the masters of large fires.

THE SALT INDUSTRY OF TRIPOLI.

In Tripoli the salt industry is a State monopoly, and in that country there are sixteen large salt-works—one at Tadjoura, two at Lavia, six at Misurata, five at Bengazi, and one at Derna. M. G. Vadala, Belgian Consul in Tripoli, says that the most important of these are the Brega, Tadjoura, and Bengazi works. As regards the Brega salt lake, situated on the western confines of Tripoli, and separated from the sea by a strip of land, not much more than half a mile in extent, this spreads its waters, in winter, over a territory exceeding 500 square kilometres, or 190 square miles; and this is the more remarkable as, in Europe, the largest and finest salt marshes—those of Italy and Spain—do not cover an area of more than 200 to 250 hectares (hectare = 2·47 acres). This marsh can supply, to any extent, salt of the very finest quality, well crystallised, and excellent for use in preserving meat and fish, and in this respect it can compare very favourably with salt of European production. The extraction of the salt can be commenced in June and continue until the rainy season in November, and in this period of five or six months as much salt as may be considered necessary can be conveyed to the sea, and is ready at any time for shipment. The roadstead of Brega is accessible at all seasons, and ships can always find a safe anchorage there, although they are obliged, on account of the shallow water, to anchor at some considerable distance from the shore. M. Vadala says that, in spite of the advantages offered and the benefits that would accrue to the Ottoman Empire and to other countries as well from the sale of the product, this salt marsh remains practically unworked. Situated in the immediate vicinity of Tripoli the small salt marsh of Tadjoura is, like almost all the African works, a natural marsh, of which the extent measures a little more than a kilometre (kilometre = ·621 of a mile) in length, from north to south, and about 800 yards in width, from east to west. A strip of land, between 600 and 700 yards in extent, separates it from the Mediterranean coast. The rains alone feed the Tadjoura marsh, and, from the commencement of April, the water is so regulated, according to the direction of the wind, as to concentrate it in a given spot to receive the salt deposit. This is done by

building up dams with the soil taken from the marsh itself, which is turned up on the borders of the trenches dug, and this operation is repeated until the water is collected in an internal basin, which does not represent more than a fifth of the total superficies of the marsh, and has a depth varying from 6 to 20 centimetres. This preliminary operation is indispensable, in order to prevent a frequent scattering of the liquid, and a rapid evaporation of a water which, having too shallow a depth, would only produce a glutinous salt, and of a nature difficult and expensive to collect. This work of concentration being effected, nature itself will do the rest. It is generally towards the end of May or beginning of June that the first symptoms of crystallisation are found at the approaches of the dam. During 30 or 40 days of constant evaporation the salt is deposited: it accumulates at the bottom of the basin, and forms a bed, which, in the most productive places, rarely exceeds a centimetre in thickness. This crystallisation is only complete towards the end of June, and it is at this time that the extraction of the salt usually takes place. The length of time that this operation lasts varies between 30 and 50 days. The salt, when collected, is carried in boats to the warehouses at Tripoli. All these different operations, from the formation of the dams to the warehousing at Tripoli, bring the cost price of the salt up to 10 francs the ton, when the yield exceeds 1,000,000 kilogrammes, but which reaches 15 francs a ton when this yield remains below 60,000 kilogrammes. The Tadjoura salt is either consumed in the city of Tripoli or sent to the Turkish markets, and the price realised is about 90 francs the ton. As regards the Bengazi salines, the most important is that situated at Sidi Hussein. This measures 13,000 metres long by 900 wide, its area, therefore, being about 120 hectares. The Juliana marsh is a little longer, but less wide. From the former, as much as 30,000 tons have been obtained, while the yield of the latter has never exceeded 1,000 tons. Each marsh is fed by sea-water, and the crystallisation, which commences in the beginning of July, is not complete until the end of August or the early part of September, and it is at this period that the extraction and transport of the salt is effected. The operation of raising the salt only finishes with the first rains, which occur generally towards the end of October, so that only about 50 days work can be counted upon. The Bengazi salt is affected by a certain bitterness, which only disappears a long time after its extraction, and has the effect of temporarily depreciating it in value.

FISHERIES OF THE SEA OF AZOV.

The British Vice-Consul at Kertch says that the fishing season, and particularly the herring fishing, of the close of the year 1891 was one of the best on record. Over 10,000,000 herrings, valued at more than £300,000, were landed by the Kertch Straits and Kertch out-bay fisheries; while sturgeon and other kinds of fish have produced another £20,000 for the same period. The Sea of Azov, with the deltas of two large rivers—the Don and the Kuban—falling into it, and only a comparatively narrow outlet at Kertch Straits, forms one of the most renowned natural fishing reservoirs of Europe. Vice-Consul Hunt says it would require a naturalist to give a complete list of fresh-water fish that abound all over it, and he only mentions the most important in commerce on account of the enormous quantities that are caught. For example, the carp, the Russian *taran* (*Cyprinus vimba*), and particularly the *soudak*. This last, fit for any table when fresh, is cured, salted, and sun-dried in enormous quantities. The greatest wealth and importance, however, is centred in what is called by the Russians, "red fish," and the caviare factories that depend upon it. Under the general name of red fish, Russians include different varieties of sturgeon, the principal being *Accipenser Sturio*, *L. Accipenser Stellatus*, and the *Accipenser Huso*. The most esteemed for its flavour and for caviare is the first, and the largest in size is the last, some of which of 700 lbs. weight are not uncommon, and in rare instances specimens up to 3,000 lbs. weight have been caught in the Azov. Some approximate idea of the abundance of fish may be formed in considering that caviare—the indispensable luxury to a Russian — is simply the destruction of milliards of sturgeon roes, and has been so from remote times. Still, only of late a perceptible diminution in sturgeon fisheries has been felt. A small quantity of herrings is caught in the Azov, as ice there prevents work on any remunerative scale, and it is only during the migration of this fish from the Azov to the Black Sea during November and December, and its return soon after the ice begins to clear, that these are caught in the Kertch Straits and the out-bay. It would be imagined that, with such a source of wealth, the fishing fleet would be an important one, but nothing of the kind, in the English sense, exists. Fishing craft are invariably open boats, as the method adopted for out-coast fishing is as primitive as barbarously destructive. The sturgeon fishing is managed by hook lines; these lines are, in fact, pretty strong ropes, from which strong and sharp hooks hang at a distance of less than a foot from each other some three or four feet below the surface of the water. One of these ropes may contain from 800 to 1,000 hooks, and, when stretched in the water, is supported by bark floaters, the ends being strongly anchored to resist the force of such powerful fish as the sturgeon; such lengths of rope are connected together so as to form one line of many thousands of hooks. There are thousands of these engines of destruction used in the Sea of Azov, and it is computed that 10 per cent., at least, of the fish tear themselves from the hook, and are carried away by the current to float afterwards in a putrid state as

a prey to birds and other fish. Fresh-water fish is generally caught by hooks in the many estuaries of the rivers, and only the herring is caught by seines and nets. The former are of enormous size, worked by gangs of thirty to forty men; the latter are only worked by individuals in small boats close to the shore. Not a single trawler exists, and salt-water fishing along the Crimean coast, except close to towns, for the local market, is absolutely unknown.

Correspondence.

THE EXTENSION OF COLONIAL TRADE.

In reference to Colonel Howard Vincent's paper I previously endeavoured to point out the true bounds of free trade, which occupies so prominent a place in this discussion, and also its relations as a doctrine of economical science. I showed that valuable as free trade is theoretically, the measure of it we have had and have called free trade has not been the sole or chief cause of the expansion of the industry of this country, and of the world at large. It is only one influence in conjunction with many great causes in operation which in our time have so enormously operated on the world.

We have, consequently, duly to regard the consideration of free trade as a factor, neither undervaluing it, nor setting it aside, neither supposing that nothing else is to be discussed, or taken into account, or adopted, in providing for our own trade, our colonial or our foreign trades.

In my letter I, called attention to the necessity of keeping in mind the true bounds of economic science, or political economy as it is commonly called, and of not overstraining its functions, and particularly with regard to political science. Although we hear so much of economic science, and we have so many professors of it, and adepts in it, and it is proposed to be taught in Board schools to boys and girls, there is no society for the discussion of it as of other sciences, abundant as are societies in London, for we cannot include the peripatetic reunion of the British Association. In Paris, there is a large and well-known society. What there is here is the Political Economy Club, which has done some very good work, but is a limited private dining clnb. The Statistical Society is generally supposed to be the society for economic science, and many of its papers belong to that domain, but it has rejected economic science as a function, many of its strait-laced members believing that "the numerical method," to which by its foundation it was devoted, is the only legitimate application of its meetings and its journal.

Two years ago, a society was formed for the publication of a Journal of Economic Science, but it did not accept the public reading and discussion of papers.

There is no society for political science, and it is only recently that the Royal Historical Society has entered on its functions. It may be noticed that already, under the care of the Rev. W. Cunningham, D.D., it has devoted attention to the historical investigation of economic subjects.

The result of all this is an anomalous state of affairs. The theoretical side of economic science is more studied than the practical, and its public representation is more in the hands of the theorists and schoolmen, than of merchants, and bankers, and men of business.

So far as the latter are concerned, they have always been known for their attachment to free trade, as the *Spectator* defines Sir Andrew Freeport to have been, and the history of economics illustrates this. Of course it is commonly imagined that Adam Smith was the inventor of economic science and of free trade—if Richard Cobden was not—but the English school of the science existed before Smith, as we see in the scores of works reprinted under the auspices of Lord Overstone. To Adam Smith we are indebted for popularising the labors of so many able men, and for throwing great light upon them. In the eyes of the public, however, he has swallowed up their reputations, and become an accepted apostle. This has in the scientific world been limited by the teachings of so many eminent writers, as Ricardo, Malthus, the Mills, and others. Nevertheless, the supposed inheritors of Smith have claimed the inheritance in his name.

The result has been that the independent public have been ousted. If anyone has got up and stated a fact or an opinion not in accordance with the imaginary canons of free trade, he has been set down at once as an ignoramus, an abetter of fair trade and of protection, and an enemy of the country. He has been very lucky if he has not been denounced in several newspapers. It is very true that the fair traders have largely contributed to bring this fate on themselves, for instead of taking measures to obtain free discussion, they have only instituted societies for the promulgation of their own nostrums.

One aspect of the matter has appeared strange, if not ludicrous in the eyes of sober observers. Here the Cobden Club has become supreme, and the apotheosis has been complete of a most fallible man, whose doctrines and whose prophecies are daily brought to nought. Weak minds cannot do without masters and authorities, though they can do without truth. Throughout the numbers of a hundred millions of English speaking men, in the other England and the Colonies, protection has extended, and so in most countries of the continent. Of course no movement can take place among the body of our people without influencing us here, and protectionism has long since been advancing and gaining adherents. Statesmen have seen this, but they have not dared to take an open course, they have protested their adhesion to the fetish of free trade, and have not dared to avow their convictions that unless some

change in our policy is adopted ruin may befall the country.

It is scarcely complimentary to public men that they have allowed themselves to be beguiled by the confusion of their ideas, and to be led away from correct conclusions by statistics fallacious in their application. The amount of mischief which has been done has been very great. In our Colonies working men, many of them assisted emigrants, have been instigated, not only to deprive our countrymen here of their share in the Colonies, but to promote artificial industries against the national welfare.

The sooner the matter is carefully and calmly discussed, and put on a right footing, the better it is for the interests, it may be said, the healthful existence, of the Mother Country and the Colonies. Mr. Mundella, on one occasion, made a most striking observation at the Statistical Society. He had just returned from the United States, and, in reference to some free trade observations which had just been made, he said he did not know how it was that arguments, which appeared to us to be so convincing, had no effect on men equally intelligent among our American brethren. That is the real representation of the controversy; and we have got to come to a right understanding and application of the facts, the figures, and the doctrines.

HYDE CLARKE.

32, St. George's-square, S.W.,
20th June, 1892.

BRITISH SHIPBUILDERS AND THE CHICAGO EXHIBITION.

Mr. McCormick under this head refers to the fact that while the export of iron and steel manufactures from Great Britain fell off 21 per cent. in the year 1891, that in Germany increased 19 per cent.

This is a matter in which I take considerable interest, viz., "the transfer of trade from British to German workshops," as Mr. McCormick very correctly calls it, but I fear that exhibiting at Chicago is but one iota of what we must do to recover the prestige which we are losing if it is not already lost.

It is not want of capability that has brought about the present state of affairs: it is the British workman's ignorance of the conditions of the foreign labour market that is the partial cause. British strikes founded the Belgian iron industry, and before long will have founded the German industries on such a firm basis that Englishmen can no longer even compete with them.

Then, again, the British manufacturer must learn to supply his customers with what they require, as the Germans do, and not thrust something else on them because it is what he is in the habit of making.

When he has learnt to do this, and to issue catalogues in the language and units of the market he seeks to supply, and has, above all, secured the co-operation of his workmen, the good old times will return, and the British manufacturer will be in a position to defy the world to compete with him.

I pen these lines not as a mere fad, but as the results of a convincing experience abroad.

HENRY W. HANDCOCK.

121, Cannon-street, E.C.
July 4, 1892.

General Notes.

GREENWICH TIME IN BELGIUM.—It has been announced in the *Moniteur Belge* that Greenwich time will in future be adopted in Belgium. The *Board of Trade Journal* reports that Mr. M. Gosselin, her Majesty's Charge d'Affaires at Brussels, in a despatch to the Foreign-office, dated the 1st May, has transmitted a copy of a Bill and explanatory statement for the adoption of Greenwich time in Belgium, and reports that the Bill has been passed and has received the Royal assent.

ARTIFICIAL PRODUCTION OF PRECIOUS STONES.—A paper on this subject by Messrs. Fremy and Feil, was printed in the *Journal*, in 1878, vol. xxvi., p. 304. A late number of the *Glasgow Herald* contains an account of some experiments in the production of gems by Mr. James Morris. It is stated that the bulk of the gems obtained are white, or rather colourless sapphires, and it is affirmed that they are hard, infusible at all ordinary attainable temperatures, and insoluble in any acid. It is further stated that by subsequent treatment some of them have taken on the sapphire blue.

BARCELONA EXHIBITION.—As a complement to the National Exhibition of Artistic Industries to be held next September in Barcelona, the Common Council of the City of Barcelona have resolved to institute an international section of reproductions from the artistic industries of all ages till 1815, in which may be exhibited the most remarkable specimens that the sumptuary arts of all ages and all countries have produced from the earliest times till the beginning of our century. The works to be exhibited in the section of reproductions must be delivered at the offices of the Secretary of the Exhibition (Paseo de Pujades, Barcelona) before the first of September next.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, JULY 15, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 13th July. Present: The Attorney-General, M.P., in the chair; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Alfred Carpmael, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Professor James Dewar, M.A., F.R.S., Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Walter H. Harris, John Biddulph Martin, William Henry Preece, F.R.S., Sir Albert K. Rollit, M.P., and Sir Owen Roberts, M.A., F.S.A.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 13th inst. Present: The Attorney-General, M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Alfred Carpmael, B. Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., John Biddulph Martin, and Sir Owen Roberts, M.A., F.S.A.

TRANSPORTATION COMMITTEE.

A meeting of the Transportation Committee was held on Thursday, 7th inst. Present: Professor Elgar, LL.D., in the chair; Sir Nathaniel Barnaby, K C.B., C. V. Boys, F.R.S., Francis Cobb, James Dredge, George N. Hooper.

IMPORTATION OF LIVE STOCK.

The following circular letter respecting the importation of live stock for exhibition at the World's Columbian Exposition has been received:—

1892.
Department No. 95.
Division of Customs.

Treasury Department,
Office of the Secretary,
Washington, D.C.,
June 18, 1892.

To Collectors and other Officers of the Customs.

The following regulations will be observed upon the entry of animals imported for exhibition at the World's Columbian Exposition at Chicago:—

1. Entry will be made at the Custom-house according to the forms prescribed in Articles 4, 6, 7, and 9 of the Special Regulations issued by this Department on November 5th, 1891.

2. Accompanying the prescribed invoice there shall be filed with the collector such a description of each animal—by distinguishing marks and characteristics—as shall identify the same when withdrawn from the Exposition for sale or export.

3. In order to avoid any risk from delay, entry of such animals may be made and completed in advance of the arrival of the vessel of importation, except that the permit will be withheld by the collector for delivery to the importer or his agent on the announcement of such arrival.

4. The Government will not be responsible for the security or safe keeping of such animals. The transfer to the transportation line will be made under the supervision of the collector at the port of arrival.

5. On arrival at the Exposition the animals will be subject to such disposition as may be agreed upon between the authorities of the Exposition and the Collector of Customs.

6. So far as applicable, the regulations of November 5, 1891, will govern importations of animals, and at the close of the Exposition imported animals on exhibition may be withdrawn for consumption, transportation in bond, or exportation under Article 20 of said regulations; but animals not so withdrawn will be sold at auction, and the proceeds, after deducting duties and charges, will be held subject to the order of the owner or importer.

7. These regulations will go into immediate effect.

O. L. Spaulding,
Acting Secretary.

ARRANGEMENTS FOR FOREIGN EXHIBITS.

The following is from the *Chicago Tribune*, June 30th, 1892:—

After months of discussion between Treasury officials, World's Fair managers, and Custom-house agents, the Treasury Department has accepted Collector Clark's plan for caring for foreign exhibits

and merchandise intended for display or sale at the World's Fair. The plan is simple, but it is believed will be a successful one, and lacks the annoying and complicated features of the system established at the Philadelphia Centennial.

The system contemplates two classes of goods which will be received into the Exposition grounds. The first class will be goods for exhibition purposes exclusively, and when so marked and accepted by the Exposition management, will be in the absolute control of Government inspectors, whose duties will be to see that not the slightest article put on exhibition is sold or released until after the Fair is over. This rule regarding exhibits will be rigidly enforced, and if any one, by mistake or otherwise, enters for exhibition purposes more goods than he intended, he will have no remedy, and must allow the goods to remain on exhibition until the Exposition is closed. However, there will be probably little trouble on this point, as the Exposition officials will pass upon all goods which enter the grounds and give official notice of all articles they accept.

The second class of foreign goods which will be allowed to enter the grounds is classed as merchandise. Goods of this class will be for sale and not exhibition alone. All these goods will be stored in bonded warehouses on the grounds when received. After they are stored, if the management desires to use any of the merchandise for exhibition purposes, it can do so by marking the goods in accordance with the regulations. All other merchandise, however, when taken out of bond for sale, must pay the regular duties assessed on such goods at the Custom-house.

Traffic Manager Jaycox had a lengthy interview with Collector Clark yesterday regarding the regulations just adopted. It was decided that the regulations and all other necessary information about the system of handling goods at the World's Fair Custom-house should be printed and sent abroad for the benefit of foreign merchants, in order that no confusion may arise upon the receipt of goods at the port of entry. Information as to the railroads over which bonded goods could be brought will also be sent abroad. Collector Clark believes that the regulations as adopted will not be at all burdensome upon exhibitors, while at the same time they will protect the Government in all its rights, and leave no loopholes for frauds.

PRICING OF EXHIBITS.

The following is from the *Chicago Times* of July 1, 1892 :—

The publication by *The* [Chicago] *Times* of the letter issued by Director-General Davis, making an arbitrary ruling in regard to the placarding of exhibits, has resulted in calling the attention of the Director-General to the *faux pas* made by his office, and he has asked for a withdrawal of the letter. It appeared that the greater part of the error was made by the State Department at Washington in duplicating a letter intended for one individual, and sending it as a circular to all United States consuls.

The text of the Director-General's letter is as follows :—

"Chicago, Ill.,
"June 29th.

"*To the Honorable the Secretary of State, Washington, D.C.*

"SIR,—The publication in England of the letter which I had the honour to address the department under date of March 11th, 1892, in reply to the inquiries of Consul Augier, of Feb. 15th, 1892, in behalf of certain woollen manufactures of Rheims, has led to the inquiry from British manufacturers whether my letter was intended to revoke the permission previously given to foreign manufacturers to placard their exhibits with the prices at which they will be sold in bond.

"The paragraph in my letter of March 11, 1892, which refuses permission to the manufacturers of Rheims to placard their prices as requested in the letter of Consul Augier was a mistake, and I desire, therefore, to have that letter revoked by authority of the department, and the following statement sent out to Consular officers as the correct ruling in the case :—

"'Foreign exhibitors in the World's Columbian Exposition will be permitted to state upon placards attached to their exhibits the price at which said products will be sold at the place of manufacture, and also the prices in bond and out of bond, or exclusive and inclusive of the Customs duties in Chicago.'

"Asking that the same publicity be given by the department to this correction as was given to my letter of March 11, I have the honour to be, very respectfully yours,

"GEORGE R. DAVIS,
"Director-General."

Proceedings of the Society.

CANTOR LECTURES.

MINE SURVEYING.

By BENNETT H. BROUGH,
Assoc.R.S.M., F.G.S.

Lecture I.—Delivered March 28, 1892.

When we consider the enormous value of mineral resources, the high importance, from a commercial point of view, of the art of mining is apparent. In this country alone, the value of minerals raised in one year has approached £80,000,000, the result of the labour of over 500,000 persons directly em-

ployed in their extraction. Last year, in the United Kingdom, the production of one mineral, coal, amounted to 185,500,000 tons, and the vast sums representing the British capital invested in all parts of the world will be readily appreciated by you all. It follows, therefore, that it is a matter of importance that the extent and character of mineral deposits should be made known. And this can only be effected by careful and accurate surveys.

The execution of such surveys is frequently a matter of considerable complication, on account of the great depths that are now attained by mining undertakings. The Ashton Moss Colliery, for example, has a shaft, the deepest in the United Kingdom, 2,880 feet in depth, and at the bottom of the workings of that mine the depth of 3,105 feet is reached. The deepest shaft in the world, the Maria shaft, at the Przibram silver-lead mines in Bohemia, is now 3,650 feet in depth. And as the task of the mine surveyor is not only to make an accurate survey of the underground workings and of the surface of the mine-royalty or concession, but also to connect the two, you will readily see that depths such as these render his task an extremely difficult one.

In this course of lectures I hope to be able to show you some of the difficulties the mine-surveyor has to contend with, and to explain to you the manner in which these difficulties are, and have been, overcome. But before passing to the subject of mine-surveying proper, it would perhaps be well for me to explain some of the terms that I shall have occasion to employ in relation to mineral deposits.

All mineral deposits are divided into three broad divisions. The first includes the beds or seams, such as those of coal, of iron ore, and of salt. These are deposits laid out more or less horizontally and parallel to the stratification of the surrounding rocks. In some cases, the beds may occur at the surface; for example, where the mineral is found in gravel, sand, or other alluvial deposits, as in the gold placers of California, and in the now exhausted tin streamworks of Cornwall. Other examples of superficial deposits are afforded by the bog iron ores of various localities. In other cases, the mineral occurs in seams interpolated between rocks of sedimentary origin, as in the case of coal and ironstone, and in that of the cupriferous shale of Mansfeld, in Prussian Saxony, a seam some 5 inches in thickness, that has been worked since the 12th century. The second class includes mineral veins or lodes, which are tabular masses differing in character from the enclosing rocks; a lode being usually defined as a repository of mineral matter, which fills more or less completely a former fissure in the earth's surface. Lastly, the deposits of the third class consist of detached masses, which cannot be considered as beds or as lodes. Such, for instance, are the red hæmatite deposits of Ulverston, the brown hæmatite deposits of the Forest of Dean, and the iron mountains of Gellivara and Taberg in Sweden, and of Missouri in the United States.

The simplest classification of mineral deposits is that based on their form, into two divisions:—(1) Tabular deposits, a class subdivided into (*a*) beds, whether interstratified or superficial, and (*b*) veins or lodes; and (2) non-tabular deposits or masses. In consequence of these differences in form, various methods of working have to be employed. In the case of coal and similar bedded deposits, the actual modes of working, although varying greatly in every district, may be broadly divided into (I.) the pillar and stall method, where the first stage of excavation is accomplished with the roof supported by pillars of coal; and (II.) the long-wall method, where the whole of the roof is allowed to settle behind the miners, no sustaining pillars being left. The latter method, when well planned, is the better as regards facility of ventilation. There is, too, less liability to accidents from falls, and the work of the surveyor is much simplified.

The mode of working mineral veins, which are usually highly inclined, differs greatly from that followed in the case of the more or less horizontal beds or seams. Horizontal galleries, termed levels, are driven upon the vein, usually 10 fathoms (60 feet) apart. These are connected by means of small shafts termed winzes. Projected on a vertical plane, the vein will thus be seen to be cut up into pillars, and to resemble the appearance in plan of a colliery worked by the pillar and stall method. These pillars are usually worked away by miners, standing on timber platforms, breaking down the mineral above them.

The first necessity of every well-managed mine is an accurate plan of the underground workings. This is almost as important to the safety of human life as efficient ventilation. At the present time, it is true, few large mines are conducted without a satisfactory plan; but there are still many mines in which mine-surveying is much neglected. The plans are

laid down without any reference to the phenomenon of the variation of the magnetic needle, and, trusting to old plans constructed in this way, the miner may drive straight into old workings filled with water, the tapping of which would be death to all employed in the mine. Many companies adopt the short-sighted policy of grudging the moderate sums required for the employment of qualified surveyors, and leave the plans and surveys in the hands of men already overtasked with other duties. The cost of mine surveys, it may be noted, is trifling. In Westphalia, for example, where the colliery plans are laid down with excessive accuracy, the annual expenditure on plans and surveys has been calculated to be 8¾d. for every 100 tons of coal raised, or 2s. 1d. for each workman employed.

Cases are known in which millions of tons of the finest coal have been lost, simply because the officials had no accurate plans to guide them in their work. In many cases, the pillars have been found to be many times larger than there was any necessity for, or to be so small as to be entirely worthless. The importance of knowing the exact size of all pillars, and the exact height of the strata above the coal, cannot be over-estimated. In short, accurate plans mean greater safety and increased profits.

As examples of errors in surveying involving great loss, danger, and future grave embarassments, numerous cases might be cited. Thus, at an important mine in Spain, an incorrect survey caused an error of 65 yards to be made in driving a main tunnel 200 yards in length; and at a mine on the sea-coast of Cornwall, a level, thought to be straight, finally emerged from the cliff some distance above the point of entrance. Again, at a mine in California, a shaft was sunk, and a 2,000-foot adit-level run in from a point below. It was desired to connect these, and the owners drove in various directions for nearly two years without success. Finally, a surveyor contracted to do it for $2,000. After a careful survey, he and his son set to work, and made the connection in two days. The importance of keeping an accurate section of a mine was shown by a fatal accident which recently occurred in North Wales. Water unexpectedly broke into a shaft in progress from an old shaft shown on the section to be 40 feet away; but in reality the thickness of the barrier, measured by Professor Le Neve Foster, H.M. Inspector of Mines for the district, was only nine feet. Here, without doubt, the loss of the miners' lives was due to the want of a correct survey.

In collieries, too, examples are not wanting. Thus in one case recorded there was an accident owing to some old workings. Trusting the old plans, which showed a barrier 100 yards away, the miners worked into the old headings, with disastrous results. In another case, an inundation occurred, by which lives were lost, from a former working being cut into. In this instance there was a correct plan of the former work, but by a mistake of the surveyor, a wrong direction was set out.

Take a case from another class of mines, that of the asbestos mines of Canada. There, great mistakes, arising from a want of knowledge of mine-surveying, were made when the mines were first opened up, many thousands of tons of waste rock having, in several cases, been tipped on to some of the richest parts of the ground. This waste rock must unquestionably be again moved before that ground can be worked.

Fortunately errors such as these are not of every-day occurrence; whilst cases in which remarkable accuracy is obtained are frequent. The wonderful results obtained from the surveys of the Mont Cenis and St. Gothard tunnels, of the Croton aqueduct in New York, and of the Ernst August adit-level draining the mines of the Harz Mountains, I shall have occasion to refer to subsequently.

Probably the most difficult and most complicated mine survey ever executed was completed last year at Przibram in Bohemia. Here in 1875 the Adalbert shaft attained a perpendicular depth of 1,000 metres (3,280 feet). The same horizon, the 30th level, was reached by the Maria shaft, now the deepest shaft in the world, in 1879. In order to facilitate the haulage from this enormous depth, it was then decided to sink a third shaft to this level; but instead of sinking a new shaft from the surface it was decided to deepen an existing shaft, and the one selected was the Franz-Josef shaft, which at that time had reached the 17th level, a depth of 1,380 feet from the surface. In order to accelerate the construction of this shaft, it was arranged to work at five different levels by sinking and rising, and in each case the coincidence on junction was so exact that not the slightest change in the timbering or masonry was required. You will be able to form an idea of the magnitude of this survey, when I tell you that, in order to obtain the requisite data for the calculations, it was necessary to

survey eleven miles of underground roads and to set up the theodolite at 684 stations.

In the United States we find a striking example, showing how a knowledge of the principles underlying mine-surveying have, in a brilliant manner, been turned to profitable account. In the copper district of Lake Superior, the celebrated Calumet and Hecla mine had the good fortune to include within its original boundary lines the most important portion of the bed of copper-bearing conglomerate, which has been worked to a depth, measured on the incline, of 3,800 feet. The inclination being $37\frac{1}{2}°$, the greatest perpendicular depth is 2,310 feet. The extreme regularity of inclination and of value in the Calumet and Hecla bed induced the owners of a concession into which it was calculated that this bed would penetrate eventually, to sink a vertical shaft to cut the bed at this great depth. The shaft was sunk by the Tamarack Company with great rapidity to a depth of 2,275 feet, when the Calumet bed was cut in all its richness, and the Tamarack mine has ever since been a large producer of copper, success having crowned this extraordinary undertaking of sinking a hole half a mile into the earth with no positive assurance that there would be any return for the thousands of pounds expended.

Turning now to the history of surveying, we are told by Herodotus that the credit of making the first surveys is due to the Egyptians, who found need of the principles of geometry in the restoration of boundaries obliterated by overflows of the Nile. Recent discoveries made among the cuneiform inscriptions on terra-cotta tablets in the British Museum show, however, that the Babylonians preceded the Egyptians in the application of geometry to surveying. Boundaries were defined in Babylonia, as is still the case in mining claims, by means of corner stones. One of these boundary stones, preserved in the Museum, bears an inscription of the date of 1200 B.C. There is also a plan, with all dimensions figured on it, on a terra-cotta tablet, representing an estate of about 8 acres.

The origin of mine-surveying must be sought with that of mining in very ancient times. The oldest known plan relating to mining is a papyrus, which can be seen in the Museum at Turin. It depicts a gold mine in Upper Egypt, and was drawn in the reign of King Mineptah, 1400 B.C. The ancient mines represented are situated in the district known as Allaki, on the Red Sea, and have been described by Linant de Bellefonds Bey. They occur in two hills, about 100 feet above the valley level, in each of which there is a wide quartz vein. These two veins have numerous branches, which have been followed in all directions. The ancient workings are remarkable for their regularity and size. There are numerous vertical shafts sunk on either side of the two veins, the shafts being in communication by means of numerous levels. The excavations are of immense size, but fallen rock obstructs a large portion, and has prevented a thorough examination. Apart from the documentary evidence referred to, it is evident that these mines were not the work of the Arabs, but of the Egyptians under the Pharaohs. The Mahommedan Arabs have a dread of working underground. All the large mines of Lorah, which furnished the stone used in the construction of the pyramids, are immense excavations in the mountain, whilst all subsequent workings at the same locality are open quarries.

There can be no doubt that these gold mines were the penal settlements of the ancient Egyptians, as is shown by the following description, given 1900 years ago by Diodorus Siculus (Book 3, chap. xii.), a description which is almost identical with that given by Agatharcides at a still earlier date :—

"On the confines of Egypt and Æthiopia, towards the Arabian side, there is a place with many mines, especially of gold, which is raised in great quantities with great difficulty and expense. The earth is by nature black, and is traversed by strings and veins of stone of such remarkable whiteness as to surpass in brilliancy the most brilliant substances. Consequently those who have charge of the mines have to employ a great number of labourers to get the gold.

"Now the kings of Egypt send to work in the mines those who are convicted of crimes and prisoners of war, as well as those who have incurred the royal displeasure, sometimes singly, sometimes together with all their kindred; thus at the same time exacting punishment from the condemned, and deriving great revenue from their labour. Those who are sent there —and they are very numerous—are all bound with chains, and compelled to work all day and all night, without any rest or chance of escape; for they are guarded by pickets of foreign soldiers, who speak languages different from theirs, so that it is impossible for them to corrupt their warders by conversation or friendly association with them.

"When the earth which contains the gold is found to be too hard, it is split up by means of large fires, and then broken by hand. When the rock is so soft that it will easily yield to the pick, it is attacked by thousands of the convicts. The whole work is controlled by a skilled miner, who knows the veins, and gives instructions to the labourers.

"The strongest of those who are condemned to this unhappy fate break the white rock with iron hammers, bringing strength rather than skill to their task, and cut tortuous passages along the vein. These men, spending their lives as they do in darkness, owing to the turns and twists of the galleries, wear lamps attached to their foreheads. Changing their position as often as the nature of the place requires, they throw down the detached lumps of ore. And this task they continue unceasingly, urged on by the threats and blows of the overseer.

"The young children creep through the galleries to the openings made in the rock, and, carefully collecting the pieces of ore as they are thrown down, carry them to the mouth of the mine to the light of day. The men over thirty years of age receive from them a certain quantity of the ore, and pound it in stone mortars until they have reduced it to the size of a pea. The women and the oldest men receive from them the pulverised ore, and throw it into mills, of which there are several arranged in a row. Working at the handles by twos or threes, they reduce it to a powder as fine as flour.

"The remainder of the process is conducted by skilled workmen, who spread the powdered ore over a broad plank, slightly inclined, and pour water on it. The earthy matter is carried away by the water along the inclined plank, but that which contains gold remains on the wood by reason of its weight. This process they repeat several times. At first rubbing the material lightly with the hand, and afterwards pressing it gently with sponges, they remove the earthy matter until the gold-dust is quite clean.

"Finally, other skilled workmen take the gold by weight and measure and put it into earthen pots, adding, in proper proportion, lead, salt, a little tin, and some barley flour. Then fastening up the pots and sealing them with clay, they heat them in a furnace five days and five nights. Then having allowed them to cool, they find in the pots none of the added materials, but only the pure gold, with very little waste.

"Such is the vast labour expended on the extraction of gold in this district. And from this description I think it is clear that gold is hard to get, as it is difficult to keep; and though all men long to get it, yet, when they have it, they find as much pain as pleasure in the use of it." *

Turning to our own country, we find that an ancient charter exists of the date of Edward IV. (1408), which, in a rude attempt at plan drawing, curiously represents the "Myne deeps," as they were then called. This document, of which a facsimile is given in Robert Hunt's "British Mining," contains a considerable amount of information. The dogs hunting signify that the Mendips were a royal chase, and therefore preserved by the Sovereign. The churches signify so many parishes. The chief mines are correctly placed, and the marginal drawings convey a fairly good idea of the mining methods employed at this date.

* For this translation I am indebted to the Rev. Arthur Chilton, M.A.

The methods of mining then in vogue are also well shown in the pieces in the ceremonial collar used by the senior member of the goldsmiths at Ghent. This collar is made in 15th century chased silver, and the mode of conducting a mine survey is shown in the first panel.

The ancient mine surveyors strenuously endeavoured to keep their art a secret. In the Middle Ages they were, in consequence, superstitiously regarded as sorcerers. The divining rod was closely associated with the practice of their profession, and, in many cases, was trusted more implicitly than the most scientific survey.

The extent to which this rod is still used for the detection of mineral deposits, springs, or hidden treasure, is much greater than educated persons would be likely to suppose. The mining journals frequently announce that adepts with this instruments are exploring for mineral veins in different parts of the world. The records of the Patent-office show that numerous forms of divining rod have been patented of late years. The *Daily Graphic* of March 11, 1891, illustrated a divining-rod expert, pointing out, at the request of the Grantham Union Sanitary Authority, sources from which supplies of water might be obtained. The *Daily News* of March 24, 1892, contains an account of explorations for water made with the divining rod, under the auspices of the Northamptonshire County Council; and the *Globe*, of March 28, contains a testimonial to the efficacy of the divining-rod from the pen of a Doctor of Divinity. These circumstances, taken together with the fact that the "dowsers," or experts with the rod, still find numerous supporters in Cornwall, in Germany, and in the Western United States, certainly justify me in regarding this subject as one not merely of antiquarian interest. Yet, a consideration of the history of the divining rod, as summarised by Chevreul, Louis Figuier, and Dr. Rossiter Raymond, clearly shows that the phenomena presented by it must be regarded as being due to self-delusion, deliberate deceit, or involuntary mendacity.

Before referring to the history of this instrument, I should like to say a few words about its form, material, and use. This,

however, is a work of great difficulty, inasmuch as the literature of the divining rod shows nothing more clearly than the contradictions of its advocates. Indeed, an old German author, Theophilus Albinus,* writing in 1704, quaintly observes: "I ween that no more confounded thing is to be found in the world than this divining rod business; for what is right and fit to one is wrong and unfit to many others, so that out of such great confusion not much good is to be presumed. For evil and lying dealings are best hidden amid this confusion, and in the muddiest water rascality likes best to fish."

The most common divining rod has always been a branch of hazel, in the shape of the letter Y. This is held in the two hands, each grasping the extremity of a prong, with the fingers closed not too tightly and the palms upwards. When carried in this manner by the adept, the rod is said to dip above mineral deposits, springs, or treasure. Though the Y-shaped rod is the most common, other shapes and materials have been advocated at different times. Thus, in a work published in 1700, by J. G. Zeidler, entitled "Pantomysterium, oder das neue vom Jahre in der Wündschelruthe als einem allgemeinen Werckzeuge Menschlicher verborgen Wissenschafft," instructions are given in the use of a great variety of instruments as divining rods, tongs, scissors, snuffers, books, the fore fingers, and so on. Indeed, the last instrument of this kind patented (British patent 1889, No. 1919) consisted, not of a rod at all, but of a flask filled with a composition of gold, silver, copper, quicksilver, and an acid or alcohol. It is suspended from one hand by a cord, and steadied by the other. If there is precious metal in the neighbourhood, it is stated that the flask will vibrate.

All authorities agree that the rod will turn in one man's hand and not in another's. It is said that a sympathy must be established between the holder, the rod, and the metal, and that many persons are wanting in the necessary qualities, whatever they may be. But how can it be explained that the rod, even in the right holder's hand, will not turn over unconcealed metal? Here you have all the conditions, but all authorities agree that the rod will not work over uncovered metal or over an open brook.

In France, in the time of Louis XIV., the rod was used for detecting criminals. The case of the murder at Lyons in 1692 is almost too well known to be quoted. A wine merchant and his wife were murdered. The authorities, who seem to have had no clue to the murderers, employed a peasant to wield the rod. He followed with the rod the alleged track of the fugitives, and finally, at the prison at Beaucoire, pointed out as one of the murderers, a hunchback recently arrested for larceny. This man confessed his guilt, and was broken on the wheel. This discovery by the aid of the divining rod seemed indeed marvellous; but later investigations have shown that it was merely a piece of clever detective work.

Ninety years later, in Paris, Bartholemy Bleton created a great sensation as a water-diviner. He is said to have followed, in the presence of crowds of spectators, a subterranean aqueduct in the Luxembourg gardens for 1,500 yards without a mistake, and the engineer of the works is reported to have said that if the plans in his possession had been lost, Bleton's footsteps would have constituted a complete survey to replace them. Later trials, however, did not give such remarkable results. Bleton would often pass over running water, when blindfold, without noticing it, and when taken several times over the same course, he would not point out accurately each time the spots which he had previously marked.

FIG. 1.

Turning to the use of the divining rod in tracing mineral veins, we find that Dr. Pryce, the early authority on Cornish mining, was a firm believer in the rod, and he devotes several pages of his book ("Mineralogia Cornubiensis," London, 1778) to instructions

* "Das entlarvete Idolum der Wunschel Ruthe," Dresden, 1794, p. 88.

in its use. An earlier writer on mining matters, William Hooson ("The Miner's Dictionary," Wrexham, 1747), is more sceptical, and he notes that "the Dignified Author of this Invention was a German, and that at the last he was deservedly hang'd for the Cheat." Agricola, the author of the first systematic treatise on mining ("De re Metallica," Basel, 1556), cautions miners against the use of the rod. The miner, he says, as a good and sober man should not use the enchanted rod, because he knows by observation the indications of nature, and to him therefore the rod is of no use. In the woodcut (Fig. 1, p. 803) illustrating this passage, a miner in the background is represented cutting his twig, while another is proceeding with it in due form to a spot where two "good and sober" miners have already found ore by digging.

An interesting old German mining token is known to numismatists, in which Cupid is represented as a "dowser" in a miner's hat and a long miner's leather, with his quiver by his side, proceeding in the orthodox manner with the divining rod. Above is written, "Ruthe weise glücklich an." On the obverse Cupid is sitting before an anvil engaged in coining, the inscription being "Dass ich aus beüt müntzen kan." The date of this silver token is 1719.

In the early works on mine-surveying, the divining rod is treated just as an ordinary surveying instrument. Thus August Beyer, who published a treatise on mine-surveying at Schneeberg, in 1749, devotes two chapters to the use of the rod, even describing its application to the solution of surveying problems. For example, if it was required to sink a perpendicular shaft to intersect the end of a level where a miner was working, a piece of the miner's leather apron was cut off and placed in the divining rod expert's hand, and where the rod dipped would be the correct place for sinking the shaft.

It is curious that we hear so little of the divining rod as we do in the religion and folklore of antiquity. Even Pliny, who never omitted to mention a superstition that came in his way, seems never to have heard of the divining rod. The theory that the divining rod was originally "made in Germany" would therefore appear to be correct.

Dr. Rossiter Raymond, in his masterly paper on the divining rod, forcibly sums up the matter thus:—"In itself it is nothing. Its claims to virtues derived from the Deity, from Satan, from affinities and sympathies, from corpuscular effluvia, from electric currents, from passive perturbatory qualities of organo-electric force, are hopelessly collapsed and discarded. A whole library of learned rubbish, which remains to us, furnishes jargon for charlatans, marvellous tales for fools, and amusement for antiquarians."

Those who wish to study what is known about this wonderful twig should refer to M. E. Chevreul, "De la baguette divinatoire," Paris, 1854; L. Figuier, "Histoire du merveillex dans les temps modernes," vol. 2, Paris, 1860; R. W. Raymond's paper on the divining rod, read before the American Institute of Mining Engineers in 1883; and report on wells sunk at Locking, Somerset, to test the alleged power of the divining rod, by Professor W. J. Sollas (Journal of the Psychical Society, 1884). In the library of the Museum of Practical Geology, there are two curious old French tracts: "La verge de Jacob, ou l'art de trouver, les tresors, les sources, les limites, les metaux, les mines, les mineraux et autres choses cachés, par l'usage du baton fourché," by J. N., Lyons, 1693; and "Traité en forme de lettre contre la nouvelle rhabdomance ou la maniere nouvelle de deviner avec une baguette fourchuë," Lyons, 1694.

In California there have been mineral prospectors claiming to be natural magnets, and not using the divining rod. But they do not appear to have met with any better results. One of these natural magnets was employed to trace a lost vein at a mine in the Grass Valley. Under his direction the company cut for many hundred feet, at a cost of £6 to £8 per foot, through serpentine rock, although this belt was exposed, and known to be barren in the immediate vicinity.

More important and legitimate is the use of the magnetic needle in the exploration for iron ore. The needle, in this case, affords valuable aid, and has been largely used in Sweden and in the United States. The theory of its use is based on the fact that certain ores become magnetic by induction under the influence of the earth's magnetism. By noting the dip of the magnetic needle, the extent of an iron ore deposit can be ascertained. Indeed, Professor Le Neve Foster records a case in which an iron ore deposit, shown on a Swedish map to exist under a lake, had been mapped in winter by observations made on the ice. Compass explorations in the United States and in Sweden being in many instances the sole source of income, you will readily understand that a skilful operator may wish to keep his

mode of procedure a secret. Frequently, therefore, the supposed supernatural properties of the divining rod are transferred to the compass. This excess of faith in some is accompanied by scepticism in others. For this, unfortunately, there are good grounds, the compass being so admirably adapted for dishonest purposes. The case is recorded of an American prospector whose compass needle, in the vicinity of an ore mass, always showed a dip of 90° when facing west, and the true dip due to local attraction when facing east. The former position, it is said, was very successfully used in selling iron ore grounds, and the latter in buying them. Similarly, in Sweden, a powerful magnet, inserted in a walking-stick, has been successfully employed to give a large dip to the needle when it was thought advisable to mislead the purchaser.

Of late years, purely scientific methods of exploring for iron ore with the magnetic needle have been introduced, and in this way important deposits have been discovered in Sweden; whilst in New Jersey, in six years, the annual production of the State increased 50 per cent. by the addition of new producing localities found by the compass.

In illustration of this lecture, there were exhibited a divining rod, a Swedish compass, and an American compass, used for exploring for iron ore.

Miscellaneous.

PRODUCTIONS OF BRITISH HONDURAS.

The following particulars and suggestions relating to the opening up and improvement of the commercial interests of British Honduras are taken from the speech of his Excellency Sir Alfred Moloney, K.C.M.G., Governor, to the Legislative Council of the Colony on 25th March last:—

"The commercial prosperity of colonies which depend on one or a limited number of articles of export is liable to disastrous fluctuations. Striking instances are to be found in the ruin of a once extensive trade, that had been confined to a single commodity, from competition and the inevitable fall in price, the ravages of rats or locusts, or a single blight. So far British Honduras would seem to have stood exceptionally in the Colonial Empire in having, for most of its history, the past two centuries, leaned for its existence almost entirely upon nature, both as regards its forest produce and rivers, as means of transport to the sea. Some of our West African possessions have stood somewhat similarly since palm oil succeeded the slave export trade; that industry is now seriously threatened by animal fats and other sufficiently available and equally suitable commodities. One of the extracts from coal tar practically killed the once flourishing and profitable cochineal trade, and also affected the indigo trade of India. Beet has contributed to the depression of the sugar trade. The substitution of iron for wood in shipbuilding, particularly in men-of-war, almost killed the large timber export trade of the Gambia and West Africa, which is also noted for its mahogany, cedar, rosewood, dye, and other woods; the marked and progressive revival of that trade, and the dimensions it is assuming, must naturally be a subject of direct concern and anxiety to all wood-cutting centres. Mahogany and logwood trees have stood prominently for several generations the commercial idols of these parts, but they are said to be getting more and more difficult of access, and, consequently, more expensive to work and get to the market.

"I do not, for one moment, question the appreciation that has been rightly, and should continue to be, extended to those valuable industries. On the contrary, I entertain every desire to promote them and to protect our forests on which they depend, a subject which, among others, occupies my attention. You will, I am confident, agree with me that the colony's motto, 'Sub umbra floreo,' should have now a more extended application.

"In view, however, of such experiences as I have referred to, it has been, I think, generally accepted that even in commerce it is a hazardous experiment to 'carry your eggs in one basket,' and, I may add, be sure, even with a wider distribution, that they have a commercial value when you take them to market, for, to guide us in establishing profitable industries we should reasonably look to the field or source of supply, the prospects and disposal of growth, and the area of the field of demand. It has become consequently part of the general Colonial policy to encourage the production of varied staple articles of export of a more or less permanent character. In such a direction, more especially in agriculture, much has been done by the active interest and assistance of the authorities of the Royal gardens at Kew to develop new industries and to distribute plants of commercial importance. In furtherance of such views, we see established, in all our West Indian possessions, botanic stations. Surely the time has come for a similar erection in this colony, which has such exceptional advantages, whether we look to climate, soil, or a market. It has been with some justice advanced that British Honduras can be made the tropical garden of North America, and why? Well 28° North is generally accepted as the frost line which may be said to mark the limit northwards, within which the growth of economic products in demand can be profitably undertaken.

"And again, as to fertility of soil, what more convincing proof can be advanced than the facts

that in the sugar areas to the north and south of the colony cane has been known to "ratoon" from 20 to 30 years, and that in the rich and naturally fertilised valley beds, bananas have repeated themselves without degeneration for 10 to 12 years, if not longer.

"The products of our cultural industries, still really in their infancy, are chiefly represented by bananas, plantains, cocoanuts, coffee, henequen—Indian corn—limes, mangoes, oranges (sour and sweet), pineapples, avocado pears, rubber, to which there should be added in time, arnatto, cacao, coir, ground-nut, indigo, jute, pita, ramie, spices, vanilla, and doubtless other promising marketable commodities.

"Even to the small extent to which the banana has been successful to the north of the frost line, where it will always be a precarious crop at best, it has proved inferior in quality to the West Indian and Central American fruit, and affords further proof that adaptability of climate does not assure profitable crops. Whilst in 1879 it did not appear among our records, its export was represented by 472,436 bunches in 1891.

"The plantain is a staple of food over a large section of negroland in West Africa. The descendants of its interesting people to the north of the Gulf of Mexico represent a consuming power of nearly 9,000,000, if the coloured population there have shown by 1890 the same growth it did for the decade which ended in 1880. Tons of this fruit from Cuba and Jamaica meet with a ready sale in Florida. Our shipments to New Orleans rose from 50,000 plantains in 1879 to 1,580,200 in 1891.

"The home of the cacao is Central America. Several valuable species are said to belong to British Honduras, and include that which is said to be the best in a marketable sense. Notwithstanding, it may be said to be here remarkable by its absence from the export cultures of the colony, which have grown in value—in round numbers—from $12,000 in 1879 to $296,665 in 1891, yet in the island of Grenada, of the West Indies, and but 5° to 6° to our south, and with an area of 133 square miles, and an estimated population in 1889 of 50,000, cacao has developed into its main export, which reached, in 1890, a value of £228,319.

"The clover-light ground nut, so desirable as a pasture where the bread-nut is not available, apart from its valuable tuber, and henequen would seem to be admirably suited for growth in the pine ridges. That interesting orchid, the vanilla, whose home is also in Central America, is one of the most valuable products, and has near to hand a rich and ever growing market. Its cured pod fetches as much as 30s. per lb. It is a plant easily propagated by means of cuttings, and has developed into a considerable export from Vera Cruz.

"Our neighbours seem to turn no small attention to the cultivation of the coffee arabica. Whilst it will doubtless prove suitable to the high areas of the colony, the introduction of the hardy and rich Liberian coffee so well suited to low-lying areas, with its comparatively heavier crop, averaging from 6 to 8 lbs. per tree, 400 of which can be accommodated on each acre, should receive the consideration it deserves. Judging from the exports from India, and the imports into the United States, there is a promising field of demand offered in the latter direction for the growth of such commodities as jute and other fibres, indigo, ginger, and spices generally.

"The cohune oil industry remains yet dormant, if I except the use for domestic and cooking purposes to which it is put among the families of mahogany and logwood cutters. Two-fifths of the colony, viz., 1,933,762 acres are, it is estimated, under this graceful palm. If we allow 25 trees to the acre, a very low average, and 1,000 nuts as the annual yield per tree, and accept that 100 nuts yield a quart of oil, this dormant industry, if awakened to full activity, would yield 276,537 tons of oil at a price per ton appreciably above that which obtains for cocoanut oil, to which it is superior.

"Then again, apart from its resinous property, which was turned, I understand, to profitable account some years back, the pine, it is estimated, covers a third of the colony, or 1,613,136 acres, and averages 100 trees per acre on our great southern pine-ridge, much more in other parts. Its wood is said to almost equal that of the yellow pine of the United States, which, in the beginning of 1888, was reported to have been nearly worked out, and might, in part, have to be re-placed by the local pine. The growth on the older pine-ridges of the colony may, when opened up, prove of sufficient age and diameter to make it worth while to have attention turned to adding this timber to our exports, as can doubtless be done with many other valuable woods unknown yet to science as well as to wood fairs.

"In Scandinavia, apart from its extensive export as a wood, from its wide use in the manufacture of matches, or from the value of its resinous properties, the pine pulped has been most profitably utilised in the manufacture of a commodity that has developed into an important rival to paper.

"The coral patches and marine islets we know as 'Cays' that fringe, to their eastward, the waters of this colony, offer a condition of site exceptionally favourable for the growth of henequen and the cocoanut trees, described as the most tender of palms as regards frost, the friend of tropical agriculturists. The area of such Cays is given approximately as 112,527 acres, which might be turned to much more profitable uses and yield than obtain at present. With even a quarter of such acreage suitable for the culture of such products as cocoanuts and henequen, it could be covered with plantations of the former, numbering 2,813,200 trees, with an annual yield of at least 100 nuts (a low average), aggregating 281,320,000, worth, at the current rate per thousand, £1,406,600, and in a condition clear of the fibrous exterior that yields the coir of commerce, here usually thrown away or associated occasionally

with mahogany chips and conch shells to fill up low-lying lots. Now I should explain that such an aggregate of nuts, on the basis of 1 lb. from seven nuts or 14 per cent. fibre, should yield 18,000 tons fibre that would realise in the London markets from £30 to £10 per ton, dependent whether suited for brushes, mats, or stuffing.

"The annual export from the colony of cocoanuts during the past five years has averaged in number 1,651,933, and in value $32,505.

"That delicious fruit, the sapodilla, if picked green, will stand shipment. The tree abounds in this colony, and apart from its valuable and durable wood, yields an extract which contributes mainly to the manufacture of what is advertised and so widely used in the United States as "chewing gum."

"Then, again, trees yielding the pimento of commerce abound in a wild and unappreciated state, yet this spice was of the value of £81,328 for the year 1890-1 to Jamaica as an article of export.

"Local prospects and foreign demand seem sufficiently encouraging to justify the establishment in these waters, on a stable and profitable basis, of a sponge industry. Varieties, ranging from yellow, or "grass," to "sheep's wool." are said to be identical with those of the Bahamas and of Florida, which fetch from 25 cents. to $1.20 per lb. in United States currency. Exhibits from British Honduras at the Colonial and Indian Exhibition of 1886 attracted marked attention, and were pronounced as excelling in quality contributions from neighbouring and established areas.

"The Bahama industry, which is said to have begun about 1842, has grown to be worth, approximately, £60,000 per annum. In 1852 it was followed by Florida, and with about the same monetary result. There some 6,000 spongers of Bahama origin, born and bred to the work, are employed over an area of about 3,000 geographical miles, or 2,208,920 acres. The area of the marine waters of this colony has been returned as 2,464,000 acres, and while I am not prepared to say that our virgin sponge grounds are co-extensive with such acreage, sufficient proof has been experimentally afforded to justify the conclusion that rich crops are locally available, and only await to be reaped.

"As you are aware, the survey for a line of railway to the frontier of the colony proceeds; the circumstances and conditions thereof have been publicly notified. The result, together with the expression of the local views thereon, which will be invited, should help materially to guide the decision whether or not this colony can, in the near future, undertake such an enterprise which, it is generally acknowledged, is essential to open up the locked-up Crown lands to the south and west that have been for generations and are practically a *terra incognita*, and likely to remain such without a railway; to encourage, further, the introduction of capital and labour; to tap and afford means of transport to rich timber areas hitherto if not unapproachable, at least unworkable, from their inaccessibility; to promote in our rich and naturally fertilised valleys the extension of small economic cultures and general agricultural industries; to develop the mineral resources of the colony in the only direction in which prospecting has so far looked with favour; and to enable our Hinterland to be reached, the climatic conditions of which will admit, it is advanced, of foreign and indigenous settlement."

PRODUCTION OF PLATINUM IN RUSSIA.

The platinum beds of the Ural mountains, according to the *Journal de la Chambre de Commerce de Constantinople*, are the only ones in the world in which this metal is found in grains. Platinum is found in Brazil and in the Cordilleras in the hard serpentine rocks, but never in the form of grains. The platinum beds of the Ural mountains are found in various districts. In the north, at Besserski, in the government of Perm, in the district of Khotourski, and in the State properties of Goroblagodatski, where sixty-six mining concessions have been granted. All the beds of the northern region are situated in the basin of the River Touri, in that of the tributory stream of Taghil, and in other tributaries higher up. On the western declivity of the Ural mountains there is another platinum bed near the River Outka, a tributary of the Tchoussova, and the basins of the higher tributaries of the Outka, near the Ural river. The platinum found in these places is in the form of grains, in sand frequently containing gold. The weight of these grains is from 17 to 21 grammes to every 1,640 kilogrammes of sand. The richness of the platinum beds varies in the same proportions. In some, the thickness of the turf covering the sand does not exceed from 2·16 metres to 2·88 metres, while in others it varies from 10·80 metres to 14 metres, so that it becomes necessary to work underground. The thickness of the platinum sands does not vary much. A noticeable characteristic of it is that they are found in the form of friable grit, and easily washable. The clayey sand is rarely met with. The beds in the northern districts of the Ural mountains are most frequently of little depth, thus allowing the turf to be easily removed and the platinum is quickly reached. The platinum found in this district contains a considerable proportion of gold, whereas that found in the Taghil district contains hardly any. Moreover, the Northern platinum and that of the Taghil district are very different in appearance. The former appears clear and very brilliant, while the latter is of a dull colour and is frequently found mixed with rare metals such as iridium and osmium. The size of the grains is about the same in the two beds. The demand for platinum for industrial purposes is relatively restricted, as it only dates from the last twelve or fifteen years. It is largely used for electric lighting and dynamo con-

ductors, and considerable quantities of platinum are now employed in chemical and other factories. During the last twelve years the annual production of platinum has averaged about 3,194 kilogrammes, of which half has been derived from the beds in the north of the Ural mountains belonging either to the State or to private persons. Throughout the whole world only about 3,270 kilogrammes of platinum are annually used, but it is anticipated that this amount will soon be considerably increased, and it is stated that the platinum beds of Bisserski can alone supply the total quantity required for the consumption of the world. When the demand for platinum was insignificant and the price very low, the gold miners who found platinum while seeking gold, frequently, it is stated, used the former instead of lead, as shot for firing at wild birds. It is only since the demand has increased that greater attention has been paid to this metal. All the platinum extracted from the Ural mountains, after having paid a tax of 3 per cent. in kind, is sent as raw ore to St. Petersburg for treatment and shipment to foreign markets.

SERICULTURE AT ADRIANOPLE.

The following information respecting sericulture in the vilayet of Adrianople, from the *Journal de la Chambre de Commerce de Constantinople*, is quoted from the *Board of Trade Journal*:—

"It is within a radius of from 30 to 40 kilometres around the town of Adrianople, the chief town of the province of the same name, that the rearing of the silkworm offers the greatest interest and where the chief centre of the production is found. Some other localities, at some distance from the chief town, also produce cocoons, but in small quantities; these villages are chiefly situated on the shores of the Sea of Marmora and on the Rodhopes mountains.

"For some years the production of the district of Adrianople has reached 500,000 okes of fresh cocoons, about 70 per cent. of which are yellow and the remainder white.

"The yield of cocoons from eggs placed for hatching is estimated at 20 okes per box of 30 grms. There are in the province 20,000 boxes, of which 15,000 of the yellow breed come from France, and 5,000 of the white Bagdad breed imported from Broussa; these eggs produce altogether 400,000 okes of cocoons. There are also produced 100,000 okes of cocoons coming from eggs obtained in the country by the breeders themselves, which are not placed for sale.

"The silkworms' eggs are not sold for ready money, but according to what they may yield. It almost always happens that more eggs are imported than are required; the egg-dealers therefore, in order that their boxes may not be wasted, offer them at ridiculous terms, and thus carry on between themselves a keen competition from which alone the peasant profits. It therefore follows that the profits of the egg-dealers from the yield of the cocoons is almost *nil*. A reasonable rate on placing the seeds is from 20 to 25 per cent. on the product, but 12½ and 10 per cent. are finally granted.

"The silk industry of the country is carried on by two spinning mills, requiring for their annual needs about 150,000 okes of fresh cocoons.

"There remains, consequently, from the total of the crop 350,000 okes of cocoons for export; but this figure is reduced to 300,000 by the process of testing, which is carried out before export, for about 50,000 okes of broken cocoons remain in the country, and are woven into common silk for local consumption.

"The cocoons thus tested are sent to Marseilles and Milan. Yellow are preferred in Italy and white in France, where their sale is easier by reason of the special uses to which they are put."

Obituary.

CYRUS FIELD.—Mr. Cyrus West Field, the successful promoter of Atlantic cables, who died at New York, on Tuesday, 12th inst., was elected an honorary life member of the Society of Arts in May, 1876, "for his valuable services in connection with the promotion of electric communication between England and America." Mr. Field was born at Stockbridge, Massachusetts, on November 30th, 1819, and on leaving the school of his native town he became a clerk in New York; soon afterwards he started a business on his own account, from which he retired in 1853. He now devoted his whole attention to the promotion of ocean telegraphy. In the pursuit of this object he is said to have crossed the Atlantic about fifty times. His first venture was the construction of a line from the coast of Ireland to that of Continental America by way of Newfoundland. He received the unanimous thanks of Congress with a gold medal in commemoration of his successful enterprise.

LORD WINMARLEIGH.—The Right Hon. John Wilson Patten Lord Winmarleigh, who died on Monday, 11th inst., at his seat, near Garstang, North Lancashire, had been a member of the Society of Arts for 40 years. He was born in 1802, and educated at Eton and Magdalen College, Oxford. After three years of travel on the Continent, he was elected, in 1830, one of the members for Lancashire. From 1832 to 1874, Colonel Wilson Patten represented North Lancashire in the House of Commons. He was Chairman of Committees of the whole House from November, 1852, till April, 1853; Chancellor of the Duchy of Lancaster from June, 1867, to September, 1868, and Chief Secretary for Ireland from September to December of the latter year. He was created Baron Winmarleigh in 1874.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 20th inst. Present: Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., in the chair; Alfred Carpmael, James Dredge, and Sir Douglas Galton, K.C.B., D.C.L., F.R.S.

KARACHI COMMISSIONER.

The Secretary has received information from Mr. James Currie, President of the Karachi Municipality, that Mr. Jehangir H. Kothari, a Member of the Municipal Corporation of Karachi, has been delegated to represent the Municipality at the Exhibition.

Proceedings of the Society.

CANTOR LECTURES.

MINE SURVEYING.

By Bennett H. Brough, Assoc.R.S.M., F.G.S.

Lecture II.—Delivered April 4, 1892.

Lengths in collieries are measured with the chain of 100 links, each link, with connecting rings, measuring 7·92 inches. The whole length of the chain is thus 66 feet. At each 10th link is a brass teller, so shaped that it indicates the number of tens. This odd length was selected by the inventor, Edmund Gunter, Professor at Gresham College, in 1620, in order to supply the surveyor with the basis of a decimal notation. An acre measures 4,840 square yards, and the square of 22 is 484; consequently, a square chain is 1-10th of an acre, and 10 square chains equal one acre. By the employment of this unit, acreage calculations, to determine the area of coal wrought, can be readily effected.

In metalliferous mines, the unit of length usually adopted is the fathom of 6 feet; and the chains employed are generally 10 fathoms in length, divided in 6-inch links. In the Continental mines, the metre is now the general unit of length. The most accurate measurements are made with a steel band, a delicate instrument that necessitates careful usage. In America these bands are made of great lightness, and measurements are expressed in feet and decimals of a foot.

It is interesting to compare these perfect methods of measuring lengths with those formerly employed. In an old German work on surveying, by Jacob Koebel, published in 1570, a copy of which can be seen in the British Museum, the unit of length is described somewhat as follows:—"A rood should, by the right and lawful way, and in accordance with scientific usage, be made thus: Sixteen men, short and tall, one after the other, as they come out of church, should place their left feet in a line; and if you take a length of exactly 16 of these feet, that length shall be a true rood, with which you may measure fields." This description is accompanied by a quaint illustration, showing the process being put in operation.

In the construction of mine plans the scale adopted depends on the extent of the property. For collieries of moderate size, a scale of 2 chains to the inch (1 to 1,584) is found useful; whilst scales of 3 chains to the inch (1 to 2,376) or of 4 chains to the inch (1 to 3,168) are adopted for larger properties. Besides these, the Ordnance scale of 25·44 inches to the mile (1 to 2,500) is sometimes used. With this scale the necessity of preparing a surface plan is obviated, and there is the advantage that a square inch represents an acre. At a few large collieries the workings are also represented on the Ordnance map of 6 inches to the mile (1 to 10,560), so that the whole area and system of working can be seen at a glance.

For the plans of metalliferous mines in this country no scale is prescribed by law, and the variety of scales used presents great difficulties with regard to the comparison of the plans of different neighbouring mines. Scales of 4 fathoms (1 to 288) and of 8 fathoms to the inch (1 to 576) are perhaps the most usual.

The most accurate mine surveys that I have ever met with are those of the Pennsylvania anthracite mines. The law in that State re-

quires plans of all workings on a scale of 100 feet to the inch (1 to 1,200). This scale is rather too large for convenient reference, and working plans are frequently constructed on a scale of 200 or 300 feet to the inch. These plans show all the important surface features, buildings, streams, roads, and railways, as well as the underground workings, the latter being usually drawn in blue, red, or green ink. When several seams are worked, the workings on each seam are shown in a separate colour, this precaution being especially necessary where the workings on one seam are directly above those on another. Besides the general plan, other plans showing the workings on each seam are usually made, and blue-prints of these are furnished from time to time to the underground manager.

In acquiring information with a view to laying down on paper the position and extent of mine workings, the magnetic needle has long been employed. In using the needle, however, it is necessary to know the declination in relation both to the locality and to the time, for it varies not only in different places but also from year to year. At the present time in London the needle points 17° to the west of the true north, an amount that annually decreases at the rate of about seven minutes. In the year 1580 the needle in London pointed 11° 36′ to the east of the true north; in 1663 it pointed due north, and it attained its greatest western declination of 25° 41′ in 1818. Since that date it has regularly decreased. The first observation of the declination appears to have been made in Paris in the year 1541. Regular observations, however, were not made until the middle of the 17th century. In a scarce work in my possession, bearing on the title-page:—"*Humane Industry*, or a History of most Manual Arts, Deducing the Original, Progress, and Improvement of them. Furnished with variety of Instances and Examples, showing forth the excellency of Humane Wit. London, Printed for *Henry Herringman*, and are to be sold at his Shop at the Blew-Anchor in the Lower Walk of the New-Exchange, 1661," the importance of a knowledge of the declination is fully appreciated, for it is stated that the compass "is not brought yet to that perfection, but that it requires some rectification and amendment; for the Magnetique Needle doth not exactly point to the North in all Meridians, but varies and swerves (in some places more, in some places less) from the Direct posture, Configuration, and Aspect of the North and South, which puts seamen to much distraction, and makes them run oftentimes on dangerous errors. *Van Helmont*, a great *Paracelsian* of *Germany*, professeth a readie way to rectifie this grand inconvenience, namely how to make a needle that should never vary or alter from the right point, which may be performed by a strong imagination, as he saith, thus; If a man in framing the Needle shall stand with his back to the North, and place one point of the Needle (which he intends for the North) directly towards himself, the needle so made shall always point regularly and infallibly toward the North without variation. I wish that some *Fancy-full* man of an exalted imagination would make some Needles for experiments after Helmont's direction, since it is a business of great concernment to the publique Weal, to have this business rectified."

A description of the miner's compass is given in the oldest treatise on mining, a work written in German, and published in 1505. No copy of the first edition of this "well arranged and useful little book," as the anonymous author modestly calls it, is known to exist, and copies of later editions are rare. The title-page of the 1539 edition bears the following words:—"Ein wolgeordent un nutzlich büchlin wie man Bergwerck suchen und finden sol | von allerley Metall | mit seinen figuren | nach gelegennheyt, dess gebijrges | artlych angezeygt | Mit anhangenden Bercknamen | den anfahenden Bergleuten vast dienstlich, mdxxxix." The book is written in the form of a dialogue between Daniel, the mining expert, and Knappius the young. The woodcut of the miner's compass shows that the dial is divided, not into degrees, but into twice twelve parts or hours, the north being marked as midnight, the south as noon, the east as morning, and the west as evening. The accompanying description appears to refer to the declination of the needle; but the passage is so obscure, that Dr. H. von Dechen, who has made a careful study of this work, regards its meaning as doubtful. In the library of the Freiberg School of Mines, there are copies of four editions of this interesting work. The libraries of Dresden and Munich possess the 1518 and 1529 editions, and the Germanic Museum at Nuremberg has also a copy of the 1518 edition. The copies available in this country are later reprints. In the library of the Museum of Practical Geology, this work will be found in two volumes—"Ursprung und Ordnungen der Bergwerge im Königreich

Böheim, Leiptzigk, 1616," and "Corpus juris et systema rerum metallicarum, Franckfurt, 1698."

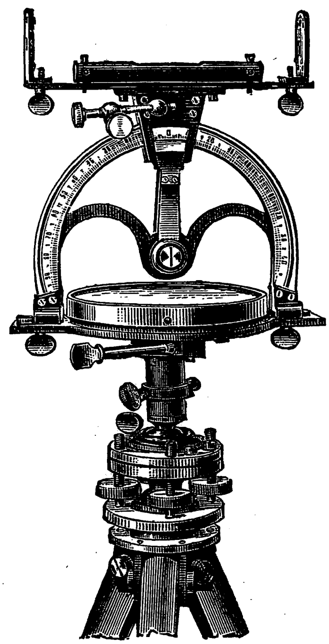
The compass described by Agricola, in the fifth book of his *De re metallica* (1556) is of a very primitive character. It consists of a series of seven concentric circles, filled with wax of different colours; in the middle is a depressed receptacle to contain the magnetic needle. The dial is divided into twice 12 hours, a mode of graduation still frequently used in German mining dials. When in use, the instrument was so placed that the needle pointed to the north, and a scratch was then made in one of the wax circles, to indicate the direction, the bearing of which was required. The laying down of the results was effected by repeating the survey at the surface, the object of surveys in those days being merely to determine how near the underground workings were to the boundary of the concession. An old compass of this type, marked 1541, found at Neudorf, in the Hartz, is preserved in the Clausthal collection, and a similar one, that belonged to Galileo, is shown in Florence.

In the 17th century mines were surveyed in a somewhat similar manner, as is shown by the description of the method of surveying adopted in the Derbyshire lead mines, given by Thomas Houghton, writing in 1688, in his "*Rara avis in terris*, or the compleate miner." Even, in the middle of the last century, dialling was carried on with appliances of a very primitive character. "The instruments used," writes Dr. W. Pryce, in 1778, "are a compass without a gnomon or a style, but a centre-pin projecting from the middle of the compass to loop a line to or stick a candle upon, fixed in a box exactly true and level with its surface, about 6, 8, or 9 inches square, nicely glazed with strong white glass, and a cover suitable to it hung square and level with the upper part of the instrument; a 24-inch guage or two-foot rule, and a string or small cord with a plummet at the end of it; a little stool to place the dial horizontally, and pegs and pins of wood, a piece of chalk, and pen, ink, and paper." Dr. Pryce warns "those who take no account of the points or angles of the compass, but in lieu thereof chalk the bearing of the line they measure with on the board the compass lies in; for if they are not exceedingly careful and precise in their operations, they may commit almost unpardonable and irretrievable blunders. Yet formerly, before penmanship and figures were so generally understood and practiced among the common Tinners, as they are at present, most of our Mines and Adits were dialled for in this manner."

Towards the end of the last century, the dial was fitted with sights, by means of which the direction of the station-line could be taken with precision, and successive improvements introduced in the construction of this original miner's dial have finally resulted in the beautifully constructed instruments that you see exhibited to-night.

In its simplest form, the miner's dial consists of a circular box of brass divided into 360°, with a magnetic needle freely suspended on a finely pointed pin fixed in the centre of the circle. The instrument is provided with a glass cover, and also with a brass lid to protect it when not in use. Perpendicular to the horizontal plane of the instrument are two brass plates, or sights, with fine slits cut in them, carrying plain wires. The compass box is attached to a tripod-stand, a ball and socket joint furnishing the means of levelling the instrument.

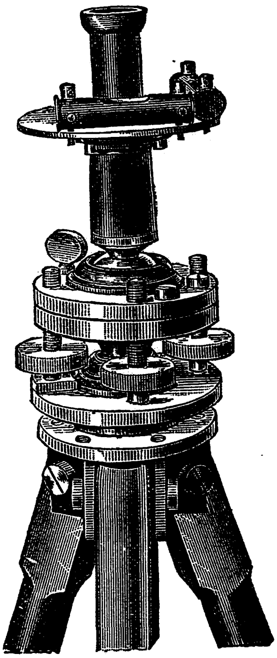
Fig. 2.



In later forms, levelling screws are added, and two small spirit levels are placed on the dial plate. For taking vertical angles, in the old type of miners' dial, the brass cover protecting the glass was used as a clinometer. A vertical arc is now used, which may be placed

at pleasure across the central line of the compass (Fig. 2, p. 811). This is in general use in metalliferous mines. In collieries, where the vertical angles required are never excessive, a side arc is usually employed. In the best form of side arc, invented in 1850, by Mr. John Hedley, H.M. Inspector of Mines, the sights are carried by an outer ring concentric with the dial. In order that the compass graduations shall not be obstructed when the vertical arc over the dial is used, the standards in the Whitelaw dial are dispensed with, and in their place is a movable semi-circular arc, carrying the bar with the sights. In the Thornton dial, the vertical arc is made to fold down out of the way of injury when the instrument is carried from place to place.

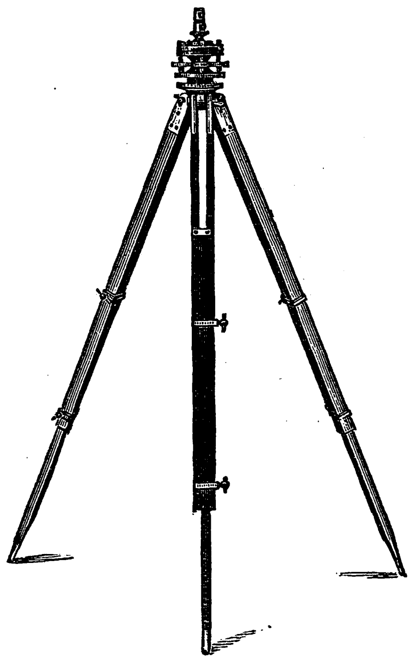
FIG. 3.



On account of the increasing use of iron and steel in mines in the form of rails, props, or machinery, the number of mines in which the magnetic needle is not affected is extremely small. It is therefore necessary to employ an angle-measuring instrument that shall be independent of the needle. An instrument of this kind consists of a horizontal circle graduated in 360°, with a circular plate above it, capable of independent rotation. Since either of these plates can be fixed while the other moves, a means of measuring angles is afforded. All modern miner's dials are made on this system, the method of surveying by measuring angles without the use of the needle being known as "fast-needle dialling." The angles are read with great accuracy by means of verniers, and when a telescope is fitted on the vertical arc in place of the sights, the instrument becomes to all intents and purposes a theodolite that can be used for field-surveying.

In order to ensure accuracy, it is advisable in underground surveys to use three tripods, one for the instrument and the others for the lamp or candle. The latter is fitted in a special holder (Fig. 3) provided with two spirit levels, and capable of being levelled by a ball and socket joint and levelling screws. One of the best forms of tripod is that made by Messrs. E. T. Newton and Son, of Camborne, who employ slotted legs with thumb-screws for tightening them when any wear takes place owing to the shrinkage of the wood under climatic influences. For surveying over very irregular ground, these tripods (Fig. 4) are provided with sliding adjustable slotted oak legs, a device that greatly economises time in levelling the instrument.

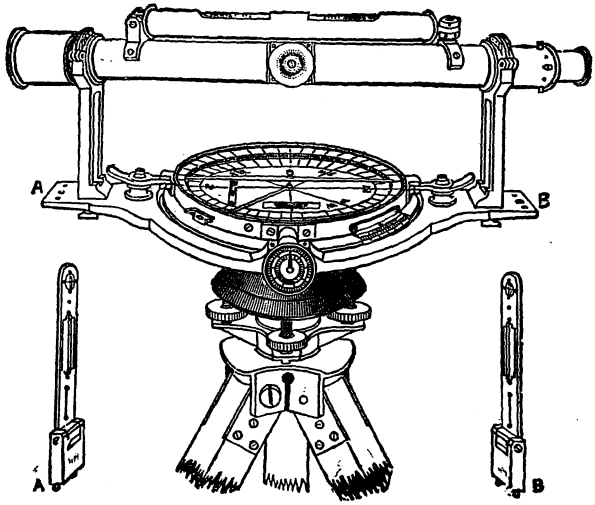
FIG. 4.



One of the latest forms of dial, and one presenting many interesting features, is the Henderson dial. In place of the horse-hair sights so largely used, a split-sight, consisting

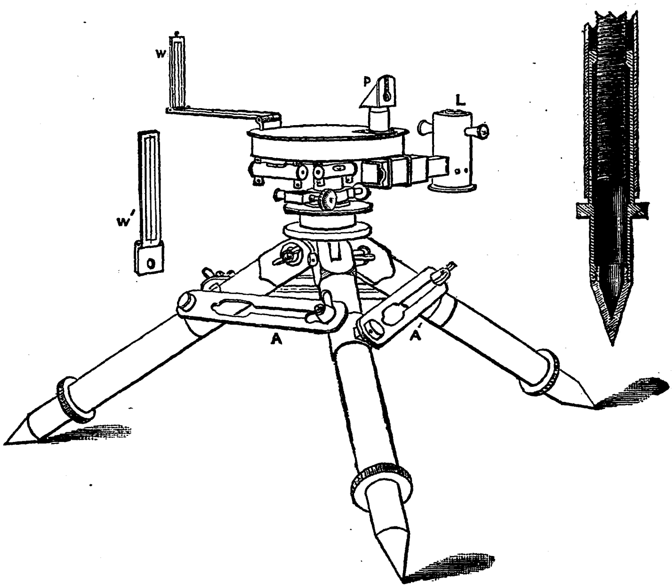
of a fine slit in a metallic plate, is adopted. The needle is mounted on a ruby, in place of the ordinary agate. To the north-seeking end of the needle an aluminium vernier is fixed, so that magnetic bearings can be read with great precision. Lastly, there are two sets of folding sights, one pair revolving within the other. The fixed sights are always

FIG. 5.



in line with the back object in fast-needle dialling, whilst the inner or revolving sights adjusted to the forward object give the angle of deviation from the original direction. This enables any error made in the progress of the survey to be at once detected. The use of two pairs of sights is not altogether new. A similar idea is made use of in the auxiliary

FIG. 6.



telescope (*lunette témoin*) in some French theodolites, and the two pairs of sights are also adopted in a graphometer or primitive theodolite in my possession, made at Brunswick before 1630.

The best instrument for colliery use is the Davis dial (Fig. 5), the special features of which are the Hedley form of side arc for taking vertical angles, and an arrangement by which bearings may be taken simultaneously with

the magnetic needle and with the vernier, the latter automatically checking the former. In the latest form of this instrument, the side arc is replaced by a fixed circular box—1¾ inch in diameter—with a hand traversing a dial-plate divided into 90°. This new form of arc presents the advantage of being so compact that it does not interfere with the manipulation of the screws under the body of the dial. For facilitating the levelling of this instrument—an American invention — the Hoffman joint has been adopted, a tripod head that combines the play of the ball and socket joint, with the accuracy and rigidity of the levelling plates of the theodolite.

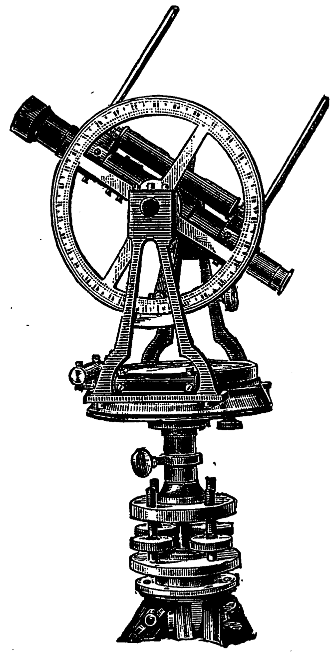
In the time at my disposal it is impossible to specify all the improvements that have been introduced in the construction of the miner's dial. All these improvements tend to make it approach more nearly to the theodolite. An experiment of a novel character, however, has been tried by Mr. Stanley, who has adapted the prismatic compass of the military surveyor for use underground. In this instrument (Fig. 6, p. 813) the floating ring is made of transparent celluloid, and light is thrown under it from a small movable lamp by means of a large prism. The adjustment to level the compass-box is effected by screws placed longitudinally up the legs.

We now come to the instruments for measuring angles, whether horizontal or vertical, with great precision. Of this class the theodolite is typical. There are many forms of theodolite, but the principle in all is the same. A telescope is mounted on both a vertical and a horizontal axis, in such a manner that the partial or complete horizontal or vertical rotation of its optic axis may be measured in degrees of arc and their fractions. The three chief types of theodolite are (1) the plain theodolite, in which the vertical arc is a semicircle; (2) the transit theodolite, with a complete circle as vertical limb; and (3) the Everest theodolite, in which the vertical limb consists of two opposite sectors, of about 90° each. It is unnecessary for me to discuss the construction of these instruments, as this subject was exhaustively dealt with by Mr. W. Mattieu Williams in a course of Cantor lectures, in 1879, and more recently in Mr. W. F. Stanley's admirable treatise on surveying instruments (London, 1890).

Since 1832, the theodolite has been used more or less in all mine surveys, where great accuracy was desired. Theodolites specially constructed for underground work are now made in great numbers by the Continental and American instrument makers. In this country, however, though the theodolite is used to a certain extent in mine surveys, the tendency has been to improve the construction of the miner's dial, making it more and more like the theodolite, so that with it results can be obtained as accurate as those made with a Continental or American mining theodolite of the same size.

The mining transit theodolite (Fig. 7) made by Messrs. E. T. Newton and Son, of Camborne, is furnished with a large (6 inch) compass box, so as to give greater accuracy in the readings of the needle than is possible with the small compass box usually fixed to English theodolites.

FIG. 7.



Besides the telescope, there is a pair of ordinary sights for work in confined spaces underground. When the theodolite is used underground, it is necessary to illuminate the cross-wires of the eye-piece; and in this theodolite, this is effected by means of a hole drilled in the supports, and a small mirror placed at an angle of 45° in the axis of the telescope, a lamp being fixed near the supports. In other cases, the illumination is effected by reflecting the light into the telescope through the object-glass.

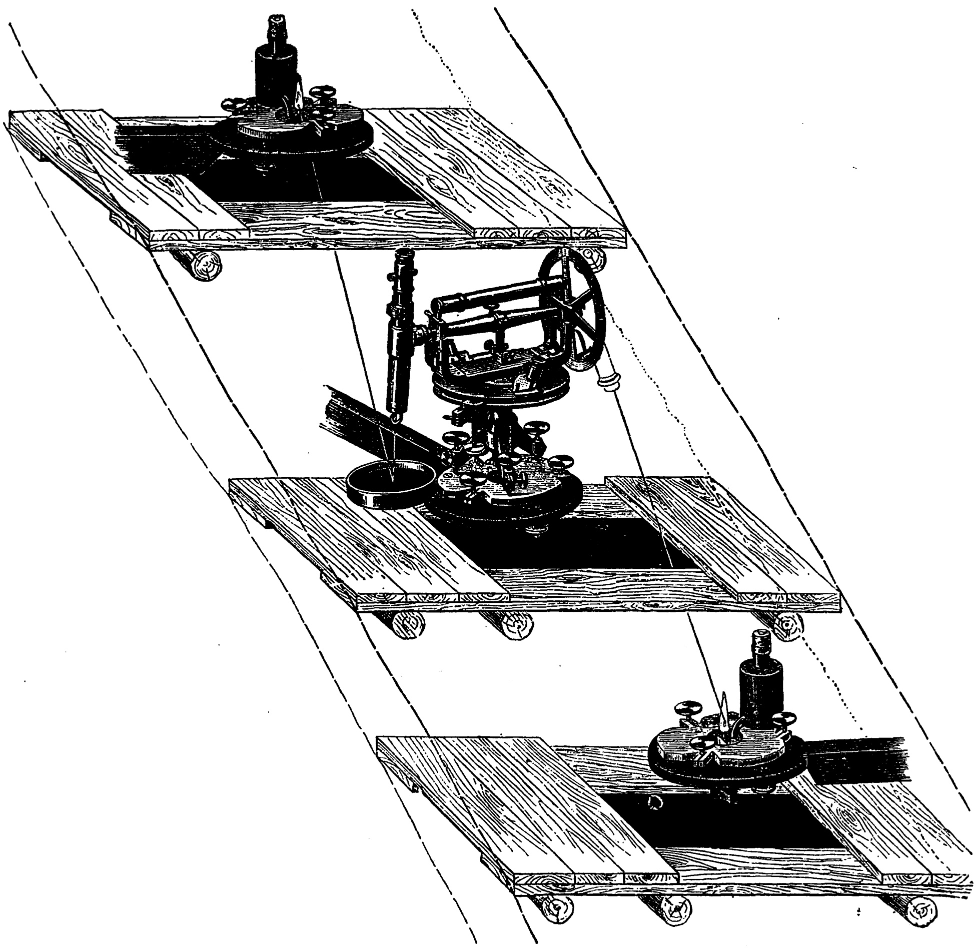
The German transit theodolites specially constructed for underground work differ in many respects from the English ones. The

instrument is invariably supported on three levelling screws, instead of on the four that are usually employed in this country. It rests on a tripod table with extensible legs, and risk of upsetting is prevented by a screw fixed in the tripod-head acting against a spring which draws the instrument constantly down when attached. The horizontal circle is protected from dust by a metal plate, and white porcelain shades are supplied for deflecting the light on to the verniers.

For surveying in shafts, it is frequently found advisable to use a theodolite with an eccentric telescope, a diagonal eye-piece being used for vertical sighting. In place of this an artificial horizon may be used, it being then merely necessary to sight down to the image of the flame. Fig. 8 shows the mode of using the artificial horizon adopted by Professor Borchers in the German mines.

A useful theodolite (Fig. 9, p. 816) for surveying work is that designed by Mr. Stanley. It has an eccentric telescope, with a pair of sights for use in confined spaces. These are made on a new principle, the sights being placed in two windows, and formed of two needle points of platino-iridium. The height of the instrument is 6 inches, and its weight 13 lbs. Two other theodolites exhibited here to-night present features of novelty. (1) The 6-inch transit theodolite made by Messrs. Davis and Son shows the application of the Hoffman joint and centering-plate to instruments of this class. This theodolite is furnished with a trough compass, in which the needle is contained in a long narrow box, whereby a considerable economy of space is effected. (2) The 5-inch telemetrical theodolite or tacheometer,

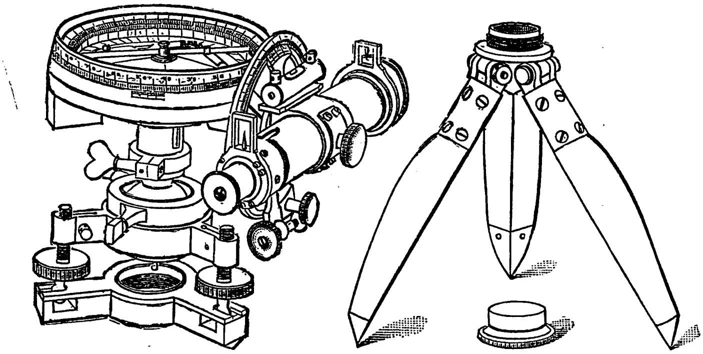
FIG. 8.



made by Mr. W. F. Stanley, shows the manner in which chain-measurement may be dispensed with, the distances being obtained by measuring the image of a distance staff, as it appears at the focus of the telescope, a method of surveying that is described at length in a paper communicated to the Institution of Civil Engineers in 1888 (vol. xci. p. 282). In this instrument the work is not so much built up in pieces, as is usual in other theodolites, but every casting is, as far as possible, shaped out of the solid to the finished form, so that great lightness and rigidity is obtained.

The adaptation of aluminium to the construction of surveying instruments, where lightness is important, is well illustrated in some of the instruments exhibited. On inspecting these instruments, you will see that the castings are free from blow-holes, and that they dress up cleanly. An advantage that aluminium presents over brass is its resistance to corrosion by the atmosphere and moisture. It does not require a coating of lacquer, as brass instruments do, and its unprotected surface keeps clean and bright. The great advantage of lightness will be readily appreciated by those who have had to carry surveying instruments of the usual construction through the tortuous passages of mines, and up the sides of steep mountains, where the slightest weight becomes a grievous burden. Messrs. J. Davis and Son, who are using aluminium for the construction of mine-surveying instruments, inform me, however, that they find it a very awkward metal to work. It is almost impossible to cut a good thread, and, in the more important parts of the instrument, they find it necessary to bush with gun-metal. From their experience, they think aluminium is not suitable for parts of instruments where an occasional stress has to be borne, as, when once strained, it is almost impossible to restore the original shape and adjustment.

FIG. 9.



In underground surveys, for long station-lines, a candle-flame is the best object to sight, care being taken to shield it from draughts. With shorter lines it is advisable to sight a plumb-line suspended from the angular point. In the anthracite mines of Pennsylvania extremely accurate results are obtained with a plummet-lamp, a brass lamp suspended by two chains from the angular point and terminated below in a conical plummet. When the safety lamp has to be used, it may be supported on a truly horizontal tripod-rest, and in this case it is advisable to use three tripods, a central one carrying the instrument, and two others carrying safety lamps in brass cups for back- and fore-objects respectively.

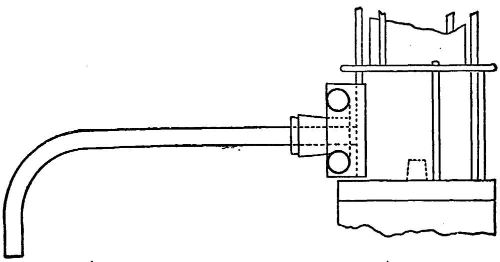
In reading the graduations of the theodolite, a brass lamp, free from iron, should be used. Unfortunately, all safety lamps give a poorer light than the open lamp or candle, and their construction will not permit of the flame being brought near the verniers. The supply of light necessary for reading the verniers of theodolite underground is, therefore, a source of considerable difficulty to the mine surveyor. For this purpose, I have seen the electric light successfully applied in the Schemnitz mines in Hungary, where incandescent lamps are used as objects to be sighted; and a smaller incandescent lamp is used for reading the verniers, the electric current being supplied from an accumulator.

In fiery collieries, where the dim light of a safety lamp has to be used, the inconvenience is especially great. Attempts have been made to increase the illuminating power of such lamps by the addition of lenses or reflectors, with more or less satisfactory results.

An ingenious device recently suggested by Professor Brathuhn, of the Clausthal School of Mines, will probably come into general use. To two of the rods outside the glass cylinder of the safety lamp (Fig. 10) a small plate is fastened by two screws. In the centre of this plate, opposite the flame, a tube is inserted, and into this a bored cork fits. Through the bored cork passes a curved glass rod, with a circular section 0·43 inches in diameter. The light which passes in at the terminal surface is totally reflected by the curved surfaces of the rod, and passes out at the lower end in full intensity. The free end of the glass rod, which can easily be moved in its cork-holder, is placed over the vernier, and a steady adequate light is obtained. Even in mines free from gas it appears worth while to use a light safety lamp for theodolite work, as the flame is so steady and so free from smoke.

The Continental method of surveying mines with the magnetic needle consists in suspending a compass and a clinometer to a

Fig. 10.



stretched cord representing the line of sight. The compass and the clinometer are read, and the length of the line measured. In this way the bearing and inclination of the station line are determined, and the plotting length is calculated. The hanging compass, which was invented by Balthasar Roessler, who died at Altenberg, in Saxony, in 1673, is so constructed that it shall assume a horizontal position when suspended to the cord. The compass may be removed from the hanging-instrument and placed in a plotting-frame, a truly rectangular plate of brass with a raised ring in the middle for the reception of the compass box. The survey is thus plotted with the actual instrument used to make it, and consequently with the same degree of approximation. Care must of course be taken to avoid the presence in the drawing-office of iron objects that may affect the needle. Indeed, at a large French colliery, a drawing-office has been built in which all the ironwork has been replaced by copper, for the purpose of employing this instrument without inconvenience. The hanging compass in Germany and France is being replaced by the theodolite; but it is still found useful in narrow workings. It is occasionally used in America. Thus, in surveying the Longdale iron mine in Virginia, Mr. G. R. Johnson has found it a useful auxiliary. The four main adit levels of the mine having been surveyed, and their entrances connected by level and theodolite lines, it remained to survey the stopes and workings in order to make a complete map, and to test the accuracy of the foregoing work. To do this with the theodolite and level was out of the question, both on account of the roughness of the workings, and also because they were much too small—so small in places that a man could scarcely crawl through them. The hanging compass was consequently used with very satisfactory results, the ends of the survey coinciding with the corresponding points determined in the theodolite survey.

In illustration of this lecture the following instruments were exhibited :—

By the Department of Science and Art.

Small mining transit theodolite, from the South Kensington Museum.

Safety lamp for reading verniers underground, from the School of Mines Collection.

By Messrs. Davis and Son, Derby.

1. Six-inch Davis's improved Hedley dial, with Hoffman patent joint, telescope and sights interchangeable.
2. Five-inch Davis's improved Hedley dial, with small Hoffman joint.
3. Four-inch miner's dial, with ball and socket joint.
4. Hoffman joint in aluminium.
5. Dialling lamp.
6. Davis's dialling lamp.
7. Six inch transit theodolite, trough compass, Hoffman joint, and centering plate.

By Mr. W. F. Stanley, Holborn, W.C.

1. Outside-reading miner's dial.
2. Prismatic dial.
3. Hanging dial.
4. Lamp with fittings for extra tripod.
5. Electric lamp for surveying.
6. Five-inch new model, telemetrical theodolite, telescope supports and axis in one casting, telescopic

tribrach mechanical stage, subtense points for taking distances, trough compass.

7. Mining transit theodolite.

By Mr. Steward, Strand, W.C.

Francis's mine-surveying instrument.

By the Lecturer.

Agricola's mining compass.

Graphometer of 1630.

Miscellaneous.

THE AGRICULTURAL POPULATION OF HUNGARY.

Sir A. Nicolson, H.M. Consul-General at Buda Pesth, says that Hungary may be divided into four main sections. The most important of these sections is the Alföld, lying in the heart of the land, and probably the most fertile plain in the whole of Europe. The second section is the northern portion of Hungary, which extends between the Danube and the Theiss. This is a mountainous, wooded district, where agricultural operations are carried on with difficulty, and rarely with success. The third section is on the western bank of the Danube, forming a district skirted by the Danube, the Drav, and the Austrian frontier. In the midst of this district is the great Bakonya forest, and the Platten or Balalon lake, a fertile region inhabited by the most industrious population of Hungary. Transylvania forms the fourth section, a hilly, wooded country, with a cold, damp climate, principally the region of mines and forests. The majority of the population is composed of Roumans, or Wallachs, the south-eastern portion being inhabited by Hungarian Szeklers and German Saxons. Agriculture is variously pursued in the different regions. The fertile plain of the Alföld is eminently adapted to an extensive system of agriculture, but owing to the scattered and scanty population, the large estates during harvest time are obliged to procure labourers, and frequently for the whole year, from the more thickly populated and less fertile regions in the north of Hungary. The labourers on the Alföld enjoy the most prosperous existence; their wages are the highest, and the position of the hired hand is a satisfactory one. It is in the Alföld that the pure Magyar is to be found in the greatest number. In Upper Hungary, the stony and mountainous character of the region, with its colder and damper climate, is little suited to corn growing, and potatoes are the chief product. The population, who are almost entirely Slovaks, is very dense. Large properties are seldom to be met with; and that portion of the inhabitants who have no land of their own are compelled either to work in the forests or to migrate to the number usually of about 10,000, during the harvest, to the Alföld. Moreover, there is a very considerable emigration annually of Slovaks to the United States. There they work in the mines or at some heavy manual labour, but almost invariably return to their native land after a few years' absence. The Slovak, generally speaking, is in a backward condition, intellectually but little developed, living on a sparse and vegetable diet, and though he is said to possess the simple virtues of the uncivilised, he is still a rude, unlettered individual, given to strong drinks, and with few desires of an elevating character. In the third section, which may be said to form the western division of Hungary, the population is fairly numerous and the most economical in the whole country, the soil fertile, the wages high, and the cultivation careful and productive. The fourth section, Transylvania, has somewhat similar conditions to those existing in Upper Hungary. The cultivation of the land is conducted on very primitive methods, and the condition of the labourer is far less favourable than that of his fellow in the Alföld or in the western division. The population is numerous, chiefly Rouman, who are content with a minimum of the means of existence; and if they can satisfy their daily wants, are with difficulty induced to undertake any further work. The Saxons chiefly inhabit the south-eastern portion of Transylvania, are few in numbers, but industrious and prudent. They prefer town life rather than to work in the fields. The Hungarian Szeklers dwell principally in the extreme east of Transylvania. They are intelligent and enterprising, and are almost without exception engaged in agriculture. They are not, however, entirely satisfied with their lot, as, although they are pure Magyar, probably the descendants of the original settlers of that race, they emigrate in considerable numbers into Roumania, where they frequently change their religion and nationality, and remain in their adopted country. The field labourers may be classified into (1) the hired hands, (2) the tobacco labourers, (3) the zsellers, (4) the day labourers, and (5) the contract labourers. The difference between these several classes is not very great. It is almost the general rule for even well-to-do peasant proprietors to send out their children as day labourers, while the smaller peasant proprietors assist in all the processes of the maize cutting and harvesting in return for a share of the produce. The tobacco labourers are in a peculiar position. Tobacco is a State monopoly in Hungary. The tobacco labourers form regular colonies on the properties of the large tobacco cultivators. They make contracts with the proprietors, of which the following are the usual conditions. The proprietor gives the tobacco labourer, who has usually a family to support, from $1\frac{1}{4}$ to $2\frac{1}{2}$ acres of land, a dwelling-house and the necessary forage for one or two horses, and also 50 per cent. of the price of the tobacco which he has grown. The labourer has to undertake all the operations and work connected with the

tobacco cultivation, and to see to its transport to the place whence it is forwarded. The material condition of these labourers are said to be very prosperous. The zsellers are reminiscences of the old system of serfdom abolished in 1848. They receive cottages and a small plot of ground, and are bound to furnish the proprietor in return with so many days work in the year. In the Alföld the average day's wage during the harvest and haymaking seasons is 2s. 8d. for male field labourers, while in Transylvania and Upper Hungary the maximum daily wage may reach 1s. 4d. to 1s. 6d. During the harvest it is frequently the custom to pay the wages partly in kind, if not entirely, and in such cases one-eleventh or one-twelth of the harvest is given. With maize one-third to one-fourth is given, if the labourer undertakes the cutting, crushing, and transport. In hay cutting one-half or one-third is distributed, and one half of the second crop. The day labourers are usually provided with cottages. The contract labourers are engaged either for a whole year, as is generally the case when they come from a distant district, or for certain seasons. The contracts are written ones, drawn up before an authority, and concluded with the chiefs of the several groups of labourers. Their wages vary according to local requirements, but are much the same as those of the hired hands, who receive on an average an annual wage varying from about £2 to £5; 24 metric centners (metric centner is equal to about 200 pounds avoirdupois) of rye, 6 metric centners of wheat, and the same quantity of barley. In addition they are provided with free lodging, wood for firing, and sometimes clothing.

CANARY BREEDING IN GERMANY.

The United States Consular Clerk at Berlin says that third in money value among the articles exported to the United States from the Consular district of Hanover during the last quarter were canaries. For more than a century canary breeding has rendered bare existence a possibility to many poor people in Germany, and has brought a competence to others. Fifty years ago the industry had grown to such dimensions, that it became necessary to seek a foreign outlet for the trade. Salesmen were accordingly sent out, first through the Rhine districts, then to Belgium and Holland, and, soon afterwards, to England. The German canary dealers soon succeeded in establishing a brisk trade with St. Petersburg, the birds being brought by carrier to Lubeck, and thence forwarded by ship to their destination. Encouraged by their success, the German bird dealers, about the year 1850, began making shipments to New York. This proved a very profitable business, and after the introduction of steamship lines, birds were sent to South America and Australia. Canary breeding in Germany has, from the commencement, been chiefly a home industry of poor people. The principal seat of the industry was formerly the Hartz mountains, where the poor mountaineers, engaged chiefly in the timber and mining industries, were in great need. Almost every family then had in their sitting-room, the bedroom, or the garret, a breeding place for their birds. In the summer, the food necessary for the birds was easily obtained, and before the winter came the dealer had purchased them. After the Hartz mountains became more frequented by visitors desirous of benefiting by the pure Hartz air, the poverty of the mountaineers was diminished, and the canary industry fell off more and more. At present only fine singers are bred in the Hartz, and for these the dealer must pay a high price. The industry was then transferred to Eichsfelde, in the province of Hanover, where there are many very poor weavers. Nearly all of these are now engaged in breeding the cheaper varieties of canaries. The industry exists also in the poorer districts of Hesse, in the great Luneburg Moor, in parts of Westphalia, and among the Sudetic mountains (Erzgebirge) in Saxony. In the fruitful districts of the province of Hanover, where there is not so much suffering, the business is not carried on extensively. In recent years large numbers of birds have been bred in the cities, chiefly as a pastime. The extent of the canary breeding industry is shown by the fact that about 250,000 canaries are bred every year in Germany. Among the foreign markets, the first is the United States, which takes, in round numbers, 100,000 birds annually. Next in importance is the English market, which takes about 50,000 per annum. Then comes Brazil, Chile, the Argentine Republic, and Australia. To these countries salesmen are sent with canaries every year. The remaining birds, especially the finer Hartz mountain birds, are sold in Germany, where more value is attached to fineness of song, and where higher prices can be obtained than anywhere else The average price for ordinary canaries is from three to four marks for males. Hence the canary industry adds about 1,000,000 marks per annum to the national wealth of Germany, and this amount goes chiefly into the hands of the poorest class. The growth of the industry is said to be due to two causes—(1) the German bird dealers have already been very enterprising, and (2) the canaries bred in Germany are said to sing better than any others. About two-thirds of the canaries exported annually from Germany to the United States are imported by a German resident of New York, whose German home is at Ahlfeld, in the province of Hanover, whither the birds are brought from all parts of Germany. At Braunlage, in the Harz, this dealer has a factory which is capable of turning out every day the material for a thousand bird-cages. This material is given out to the peasants, who make the cages at home. From Ahlfeld the birds are shipped to New York *viâ* Bremen, accompanied by attendants. Each attendant has under his care about a thousand birds, each in its own wooden cage.

PRODUCTION OF INDIA-RUBBER IN BORNEO.

There is a royalty charged on rubber collected from the jungles of Borneo of 10 per cent. *ad valorem.* The different species of the plant found are, according to the United States Consul at Singapore, (1) *Manungan pulan,* which comes chiefly from North-West Borneo; it is a *Willughbeia barbidgei,* and is specially identical with the "gutta-singgarip" of the peninsula; (2) *Maugan buyok,* said to yield the best gutta of the Borneo forest; it is a *Leuconotis engenifolius*; this specie is also found in small quantities on the peninsula; (3) *Manugan manga,* which yields a very good gutta, is possibly a *Willughbeia,* as also is *Surapit,* for the latter yields the same milky exudation as *Manungan pulan,* but is said to be a bad gutta, and seldom collected. *Bertabu,* or *Petabo pulan,* is referred to as of little value as gutta, except perhaps for adulterating the better kinds. The other kinds of gutta met with in the Malay Peninsula are—(1) *Singgarip putch,* or *Gutta sudek*; (2) *Singgarip hitam*; and (3) *Gutta jelutong*—the latter is only used for adulterating. The gutta-percha production and export is much larger than the trade in india-rubber properly so called. The name is given to the inspissated juice, which is produced chiefly by *Dichopsis gutta,* called by the natives *getah taban merah,* and often confused with caoutchouc. The tree is of large size, from four to five feet in diameter, and from 100 to 200 feet in height. When growing in the forest it has a clean, straight stem, and it may be generally distinguished by the rich brown colour of the under surface of the leaves. The flowers are small, white, and divided into six petals and six sepals. The seeds—generally two in each fruit—are oily, and are eaten by birds and monkeys. It flowers in March, and the fruit ripens in June. The method of collecting the gutta is as follows:—A tree having been selected is felled, and as it lies on the ground, rings about an inch broad are cut in the bark at intervals all along the whole length of the trunk and of the branches with a parang, or Malay knife. These cuts soon become filled with the white, cream-like sap, and in about half an hour the gutta will have separated from the aqueous portion of the sap, and may be removed by rolling a small ball of it round in the cuts, to the edge of which the congulated gum adheres and forms a disc, varying in size according to the number of scores it is rolled in. These discs are then boiled in water and made into balls, and sold by the collectors to the persons who export it to Singapore and Penang. The gutta is at first white, but soon changes to pink, and finally to a brownish red. The amount yielded by a single tree about 100 feet high, and whose age was estimated to be over a 100 years, was 2 lbs. 5 ozs. of fairly clean gutta, valued by a Malay dealer at 3s. 3d. per lb. The product, therefore, of the whole tree is worth only 7s. 6d. Other species of the gutta tree in the Straits Settlements are (1) *Getah toban putch* (white), (2) *Getah toban sutra* (silk), (3) *Getah toban chayas* (liquid), and (4) *Getah toban simpor.* It is stated by the director of the botanical gardens at Singapore, that there are over 92 species altogether on the peninsula.

VELVET AND SILK INDUSTRY OF CREFELD.

The following extract from the report of the Crefeld Chamber of Commerce on the local velvet and silk industry is taken from the *Board of Trade Journal*:—

"The trade in velvet has fallen from £1,998,000 in 1890 to £1,401,000 in 1891; this is the lowest figure in the statistics since distinction has been made between the production of velvet and that of silk. The year 1891 will therefore be the worst that the velvet industry of Crefeld has experienced; it is inferior by £100,000 and £75,000 to the notoriously bad years of 1888 and 1889. The number of looms employed in hand weaving has fallen from 6,920 in 1890 to 3,351 in 1891, while there were 14,438 in 1887. There were 2,907 machine looms working in 1890, and 2,425 in 1891, a fact which indicates an important restriction in production. The velvet factories only paid £202,000 for labour in 1891, against £303,900 in 1890. This explains the great misery in the weavers' districts of the Lower Rhine, for this diminution in wages has been chiefly in respect of home industry. The diminution in the production of velvets is distributed as follows:—£275,000 less for the German market, £150,000 for England, and £150,000 for extra-European countries. This latter result may be partly attributed to the large consignments made to the United States in 1890, in view of the enforcement of the McKinley tariff, and further, to a certain extent by a change of fashion. The production of silk and half-silk tissues was valued at £2,430,000 last year, against £2,650,000 in 1890, and £2,800,000 in 1889. Beyond the dearness of the raw material, fashion is also responsible for this falling off. This branch of the weaving industry only employs 11,650 hand-looms, against 14,263 working in 1890. On the other hand the number of machine looms working has increased by about 100. The German markets has absorbed nearly half of the manufactured products. Although production diminished last year by about 8 per cent. as compared with 1890, the quantity of raw silk used has increased, because a greater quantity of tissues composed entirely of silk has been woven than previously. This is shown by the fact that there were consumed 439,000 kilos. less in 1891 than in 1890, and that a hand-loom has produced on an average £138 worth of tissues in 1891 against £131 in 1890. Wages aggregated £488,000 in 1890. Home industry received £72,000."

Journal of the Society of Arts.

No. 2,071. Vol. XL.

FRIDAY, JULY 29, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, 26th July. Present: The Attorney-General, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Alfred Carpmael, Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Lord Alfred S. Churchill, B. Francis Cobb, Prof. James Dewar, M.A., F.R.S., James Dredge, Francis Elgar, LL.D., Sir Edward Harland, Bart., M.P., Walter H. Harris, John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, William Henry Preece, F.R.S., Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Albert K. Rollit, M.P., Sir Owen Roberts, M.A., F.S.A., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, M.A., Secretary.

AGRICULTURAL COMMITTEE.

A meeting of the Agriculture and Food Products Committee was held on Monday, 25th inst., at 12, Hanover-square. Present: Earl of Faversham in the chair; R. Bannister, Earl Cathcart, Major Craigie, Dr. J. H. Gilbert, F.R.S., Colonel Sir Nigel Kingscote, Lord Moreton, G. H. Sanday, John Thornton, Dr. J. Augustus Voelcker, C. W. Wilson, Sir Jacob Wilson, and Ernest Clarke, honorary secretary.

ELECTRICITY COMMITTEE.

A meeting of the Committee for Electricity was held on Thursday, 21st inst. Present: William Henry Preece, F.R.S. (chairman); Professor W. Grylls Adams, M.A., D.Sc., F.R.S., Colonel R. T. Armstrong, C.B., R.E., Professor W. E. Ayrton, F.R.S., Professor James Dewar, M.A., F.R.S., Major-General E. R. Festing, F.R.S., J. E. H. Gordon, M.Inst.C.E., David Edward Hughes, F.R.S., W. M. Mordey, Mark Robinson, C. E. Spagnoletti, Professor Silvanus P. Thompson, D.Sc., F.R.S., Major-General C. E. Webber, C.B., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

TRANSPORTATION COMMITTEE.

A meeting of the Transportation Committee was held on Thursday, 21st inst. Present: Sir Douglas Galton, K.C.B., F.R.S. (chairman); Sir Nathaniel Barnaby, K C.B., James Dredge, and Professor Elgar.

DETERIORATION OF MATERIALS.

The following Special Decision of the United States Treasury Department relative to deterioration or destruction of materials imported for exhibition, has been received by the Secretary to the Royal Commission:—

Treasury Department, Office of the Secretary,
Washington, D.C.,
June 2nd, 1892.

Hon. George R. Davis, Director-General, World's Columbian Exposition, Chicago, Ill.

Sir,—During our recent conversation at the Department allusion was made to the question of the dutiable character of those articles imported for exhibition at the Exposition, in regard to which the practical demonstrations which are required to show their use and properties will result in their destruction, and which, therefore, cannot be exported at the close of the Exposition, as is contemplated by the law and regulations concerning ordinary importations of articles for the Exposition. In order to avoid any misapprehension of the Department's position, I will now state that a careful distinction will be made between articles which are imported for use by the authorities of the Exposition in the general economy of the same, and are therefore liable to duty, and similar articles which are imported solely for exhibition, although the consumption or destruction of the latter may be incidental to the demonstration of their fitness for the purpose for which they are intended. Articles of the latter class are entitled to free entry and need not necessarily be withdrawn from constructive warehouse "for consumption" before being thus applied, it being held in regard to them that the words "for exhibition" include such use as is implied in the practical application to them of mechanical or scientific forces to produce motion or chemical action.

Satisfactory evidence of such consumption or destruction will be accepted at the close of the Exposition as authority for closing the Customs accounts of the respective articles.

Of course, due vigilance will be required of Customs officers to guard against any misconstruction or perversion of this liberal interpretation of the Act of April 25th, 1890, relating to the Chicago Exposition.

Respectfully yours,

(Signed) O. L. SPAULDING,
Acting-Secretary.
Per J. M. C.

THE WORLD'S CONGRESS AUXILIARY.

The following letter from the American Minister to the Secretary of State for Foreign Affairs has been forwarded to the Royal Commission :—

The Most Honourable the Marquis of Salisbury, K.G.

Legation of the United States.
London, July 16, 1892.

MY LORD,—I have the honour to acquaint your Lordship that the Department of State of the United States is in receipt of a letter from Mr. Charles C. Bonney, president of the World's Congress Auxiliary, in which it is stated that, in pursuance of the course indicated in the original announcement of the World's Congress Auxiliary, which was transmitted to your Lordship in my note of February 2, 1891, with the Act of Congress approved April 25, 1890, and the President's invitation of January 14, 1891, extending to all foreign Governments a cordial invitation to participate in the World's Columbian Exposition, to be held in Chicago in 1893, the work of the World's Congress Auxiliary has been organised, to the present date, in 16 Departments and more than 100 General Divisions in which Congresses are to be held.

The preliminary organisations of these Congresses are contained in the preliminary publications of the Auxiliary, copies of which are herewith transmitted, and the accompanying printed pamphlets amply disclose the plans, aims, objects, and purposes of the Congresses.

I am therefore instructed to say to your Lordship that it is especially desired by my Government that the largest practicable participation of foreign peoples and Governments in the whole series of these important Congresses may be secured, and that it is particularly requested that a convenient number of the most eminent representatives of the various departments of human progress be selected as delegates to attend the respective Congresses, by or under the direction of each of the foreign Governments, in addition to those who will come as the representatives of the leading institutions and societies of the different countries. Such a co-operation on the part of other Governments will, it is confidently believed, tend in the highest degree to promote, strengthen, and extend those fraternal relations and mutual benefits which may now justly be regarded as the supreme object of international intercourse, and as involving a higher civilisation, and a broader human progress.

I have, therefore, the honour of communicating this supplementary invitation to Her Majesty's Government, and, in doing so, I venture to call your Lordship's attention to the brief intervening period, and to express the earnest hope that Her Majesty's Government will be disposed to give the necessary co-operation, to ensure the adequate participation of Her Majesty's subjects in these interesting Congresses.

I am directed also to say that, on receipt of the names of such delegates as may be selected to attend these several Congresses, suitable communications will be promptly forwarded to them.

I have the honour to be,
With the highest consideration,
My Lord,
Your most obedient humble servant,
(Signed) R. LINCOLN.

Proceedings of the Society.

CANTOR LECTURES.

MINE SURVEYING.

By BENNETT H. BROUGH,
Assoc.R.S.M., F.G.S.

Lecture III.—Delivered April 11, 1892.

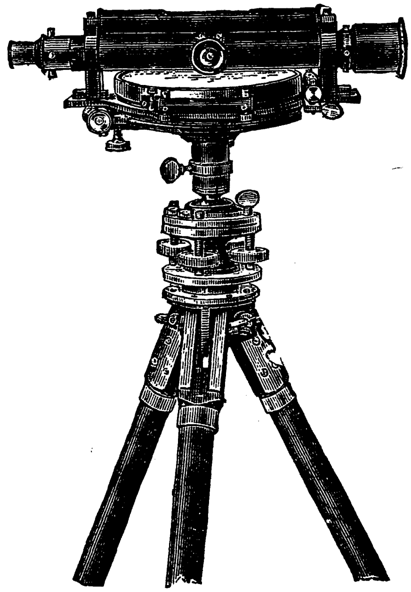
In the last lecture we considered the various instruments that are used for obtaining the data requisite for the construction of a mine plan. For the determination of the difference in height of the various points, with a view to preparing the section or vertical projection of the mine, we must have recourse to a system of levelling. The spirit-level is the instrument commonly used. The common bubble-tube is attached to a telescope in such a manner that it indicates the horizontality of the optic axis. This instrument, supported on a tripod stand, is placed midway between the two points whose difference in level is required. A graduated staff is held vertically on the first of these points, and, with the bubble remaining at the centre of its tube, the telescope is turned towards it, and the height at which the optic axis intercepts the staff is read off. The staff is then removed to the second point, and held

vertically. The telescope is directed towards it, and the height intercepted is again read off. The difference between the two readings indicates the difference of level between the two points. When the distance is too great, or the ground too much inclined for the difference of level to be determined by one operation, the process has to be repeated, the difference of level of each two successive points being determined in the way described. Thus, if the ground is irregular, we have a series of rises and falls; and regarding the former as positive, and the latter as negative, we find that the difference of level between the two end points is obtained by calculating the algebraical sum of the rises and falls. When a section of the ground is to be drawn, the distances between the several stations must be carefully measured, and the vertical distances are calculated above an assumed level line, known as the datum. Fixed points of reference, termed *bench-marks*—the levels of which are known—are selected at intervals along the line. In the Ordnance Survey of this country, the bench-marks, having the familiar form of the broad arrow, are generally chiselled on some permanent stone slab or wall.

Accurate levels are as essential as accurate plans; but, unfortunately, in many mines where very satisfactory survey work is done, there is an absence of a carefully conducted system of levels. Many colliery plans contain no levels, and the relative elevations of different parts of the workings can only be obtained approximately from the dip of the seam and by measuring the depths of shafts. Several large collieries are accurately levelled; but the elevations at each colliery are based upon a separate datum. What is required is a carefully connected system of elevations based upon a common datum, preferably that of the Ordnance Survey, the level of the sea. For continuing the Ordnance levels into the workings, Mr. J. A. Ramsay has made a very practical suggestion. In the Ordnance bench-mark, the broad arrow points upwards to a horizontal line. In order to make a distinction, he suggests that as soon as the levels become lower than the datum-line or sea-level, the broad arrow should be reversed. The levels obtained in this way may be written upon the plan in plain figures at particular points in the main roads, and when necessary may be continued into the face of the workings.

There are many forms of spirit-levels in use, and the chief of these were fully described in Mr. W. Mattieu Williams's course of Cantor lectures in 1879. For underground use, a simple level is that made by Messrs. E. T. Newton and Son, in which the telescope fits on to the plate of the ordinary dial (Fig. 11). The German levels for mining work are usually supported on three levelling screws, and in some cases the instrument is so arranged that the telescope can be moved up and down about 18°. The tripod enables any of the legs to be lengthened to 4 feet 3 inches or shortened to 2 feet 3 inches. This arrangement offers great advantages in levelling in the mine and on steep mountain slopes. Sometimes the tripod

FIG. 11.

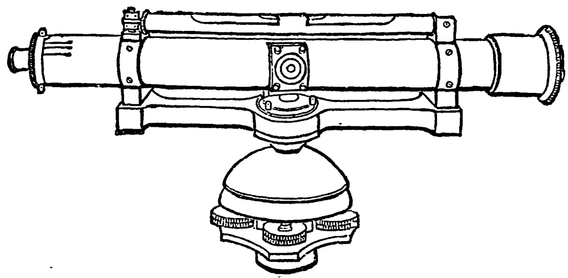


is replaced by a wrought-iron arm which can be screwed into the mine timber. This is specially useful for levelling in shafts.

Several of the latest patterns of level are exhibited to-night, and you notice that the construction of these instruments has been brought to a high degree of perfection. The 16-inch Dumpy level (Fig 12, p. 824), made by Davis and Son, shows the application of the Hoffman tripod head to instruments of this class. Stanley's new level presents many features of novelty. It has a very rigid stand, the top of the head being in one casting, and not built up. A tribrach stage instead of four parallel screws, which permits the instrument being used on a wall without the legs, prevents all possibility of straining the centre, and allows of the

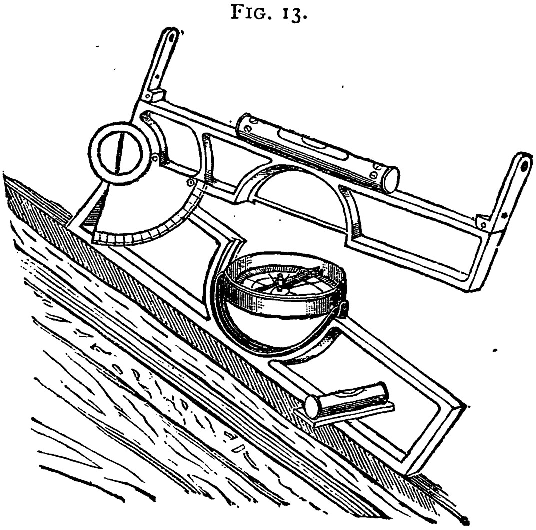
employment of an extra sensitive bubble. Instead of webs—which are a constant anxiety—platinum-iridium points are substituted. These do not cover up the divisions on staff, and neither rust nor break, are permanent in all climates, and allow of any dust being brushed off with a camel-hair pencil without interfering with the adjustment. The cap of the telescope is sighted and divided to 30° for taking rough inclines. The levelling staff generally used is that invented by Thomas Sopwith in 1838. It is telescopic, opening

FIG. 12.



from 5 feet 4 inches to 14 feet, and is clearly divided into feet, tenths, and hundredths. For levelling in mines, the staff is made 2 feet 3 inches in height, opening out to 5 feet or 8 feet. Mr. Stanley has designed a useful mining staff, which is made in lengths of 18 inches, like a folding rule. It opens out to 9 feet, and, when closed, is 20½ inches long. Messrs. Davis and Son make a mine staff, designed by Mr. G. L. Jee. It is constructed

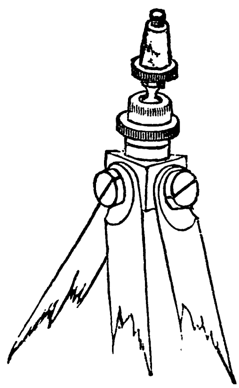
FIG. 13.



in three lengths, sliding one into the other, the bottom one, of three feet, being graduated in the usual way. The top of this length has a band attached to it, painted to continue the divisions upwards. This band passes over a roller attached to the top division of the staff, and is maintained at constant tension by a spring. By extending and clamping the lengths of the staff, any height, up to 9 feet, may be obtained.

Besides the spirit-level, other instruments are sometimes used for mine levelling. The aneroid barometer has been constructed so as to indicate a difference in a level of one foot, whilst there are various forms of clinometer that are largely used for exploratory work. A useful instrument of this class is the clinometer, designed by Mr. H. Louis, Assoc.R.S.M., which is made by Messrs. Davis in aluminium. It is a combined compass and a clinometer (Fig. 13), the compass

FIG. 14.



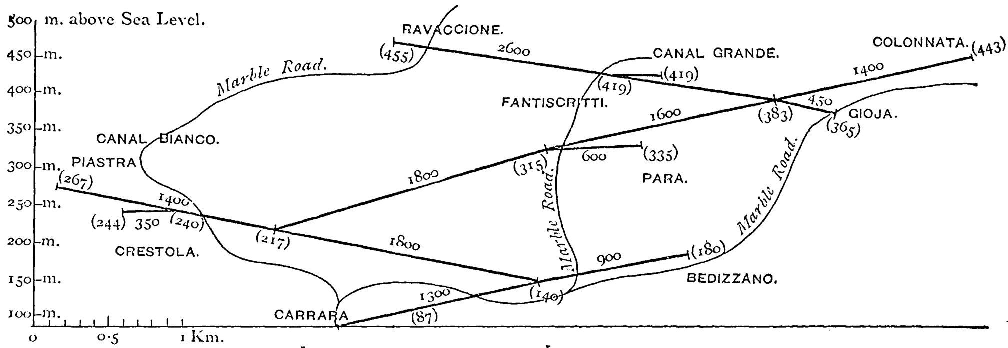
pivots being carried on a brass arc capable of revolving in the lower portion of the clinometer frame, so that the compass can be placed horizontally and read, regardless of the position of the lower limb. In this way, the dip and strike of strata, or the amount and direction of inclination of an inclined shaft, may be read simultaneously. The construction of the tripod for this instrument is shown in Fig. 14.

In connection with levelling operations underground, it is frequently necessary to

measure the depths of shafts. In perpendicular shafts the depth may be measured direct by applying rods, chains, or steel bands to the timbering of the shaft; or the winding rope may be used. The latter may, however, occasionally give rise to error. An example of this occurred in California, where a party of capitalists undertook to pay $5,000 for half of a certain mine if the owners would continue the shaft down 150 feet. After a short interval, it was announced that the shaft was complete, and one of the purchasers went to measure it. Arrived at the mine after a long and rough ride, he found the shaft very dirty, and badly provided with ladders; so being stout, he determined not to risk his neck, but to measure the depth by means of the windlass rope. With a measuring tape he found the soiled portion to be over 150 feet in length, and he returned home satisfied. Part of the purchase money had been paid, when another of the purchasers went down, and found the shaft just 80 feet in depth, the ingenious vendor having carefully soiled the additional length, relying on the uninviting appearance of the shaft deterring the purchasers from making a direct measurement.

In surveying and levelling in the shafts of the Lehigh Valley Coal Company, in the United States, a new form of plummet has recently been adopted. It consists of a vertical core 12 inches long, with eight radiating flanges 9 inches high by 3 inches wide of ¼-inch metal. At the bottom there is a circular disc acting as a web. This plumb-bob weighs 20 lbs., and has a surface area of about 630 square inches. An ordinary bob of equal weight would have a surface of 90 square inches. In a dry shaft, 500 feet deep, this form of plumb-bob will settle, under ordinary conditions, in about one hour instead

FIG. 15.



Longitudinal scale: $\frac{1}{50,000}$ *Vertical scale:* $\frac{1}{5000}$ *Lengths and altitudes in metres.*

of in five or six hours, as is the case with the older form.

In connection with mining work, there are numerous cases illustrating interesting applications of levelling. For example, the railway at the Carrara marble mines, owing to the peculiar nature of its alignment, presents several striking features. The Carrara district is situated between Spezzia and Leghorn on the Mediterranean sea-board. The marble strata cover an area of 80 square miles, and reach in places the enormous depth of three-quarters of a mile. The mines, some of which were worked by the Romans as early as 200 B.C., are surface workings at an altitude of 700 to 3,000 feet above the sea level, the aggregate annual output being about 205,000 tons. The railway, which was described in detail by Dr. C. B. Sheibner, in a paper communicated last year to the Institution of Civil Engineers, has a total length from the sea to the mines of 16 miles. The loading stages of the principal mines are situated at altitudes varying from 876 to 1,492 feet, and at short distances apart, but are separated from each other by steep ridges rising up to 3,000 feet above the sea-level. Owing to the rapid rise of the ground it was found impracticable to send a separate branch up to each mine from Carrara, following the ancient watercourses now occupied by the bullock-cart roads; and rope-traction on inclined planes would have involved placing a stationary engine of 150 horse-power at each of the nine mines. Hence the only practicable alignment with grades of 4 to 6 per cent., to be worked by ordinary adhesion, was that of a series of reverse stations shown in Fig. 15.

The grade of 4½ per cent. is fairly uniform throughout the ascent of 1,207 feet, from Carrara to the summit level at Ravaccione. It increases to 5 and 6 per cent. near the

Colonnata terminus; and the two safety sidings near Miseglia and Tornone, have a grade of 7 per cent. The works throughout are very heavy, there being 15 tunnels, with a total length of 2·1 miles, and 16 bridges and viaducts; whilst the remainder consists entirely of cuttings and sustaining walls from 16 to 46 feet in depth. This was rendered necessary, not only by the nature of the ground and the high cost of land adjoining the mines, but also by the loose masses of marble refuse, which could only be avoided by extensive tunnelling.

Another branch of engineering, in which the application of levelling is of great importance, is the setting out of aërial wire ropeways. The importance of this mode of transport in the development of mineral resources is known to every mining engineer. As a case in point, the rich iron ores of the Sierra de Bedar, in southern Spain, would probably have remained untouched to this day but for an aërial wire ropeway, 9¾ miles in length, which connects the mines with the shore of the Mediterranean, near the town of Garrucha, and which affords cheap transport to the point of shipment. An ordinary railway would have cost £100,000, whilst an aërial ropeway could be built for about one-quarter of that sum, an outlay which left a satisfactory margin for profits on the sale of ore.

In the older systems of ropeways, one endless rope is employed, serving both as carrying rope and hauling rope for the buckets. Many examples of lines of this class can be seen in the Bilbao iron ore district. The characteristic of the modern or Otto system consists in the employment of two ropes—a heavy fixed carrying rope and a light travelling hauling rope, the buckets being fitted with special devices for gripping the latter. With ropeways of this class loads of 20 cwt. can be carried, so that as much as 800 tons may be transported in a day of 10 hours.

The most important Otto ropeway yet constructed is the one I have already alluded to for the transport of iron ore at Garrucha. The line is divided into four independent sections, the two first being driven by a 30 horse-power engine, and the two last by a 70 horse-power engine. The greatest span (Fig. 16, p. 827) of the line is 918 feet, the height above the valley being 164 to 196 feet. The steepest gradient is 1 in 2½, and the tallest standard is 118 feet. The guaranteed capacity of the line is 400 tons per day of 10 hours. Since the commencement of 1890, the line has been worked in two shifts of 8 hours, and no less than 900 tons per day have been transported to the coast. Despite many difficulties, the line was surveyed, erected, and ready for work within ten months.

Another important Otto wire ropeway is that constructed by Messrs. Commans and Co. for the Sheba gold mine in the Transvaal (Fig. 17, p. 828). This is 2¾ miles in length, and has a capacity of 150 tons per day of 10 hours. The maximum incline is 1 in 1·6, and the greatest span 1,480 feet. Although the ropeway is usually considered to be quite a recent invention, an old engraving (Fig. 18, p. 828), dated 1641, in the possession of Mr. Pohlig, of Cologne, shows an aërial ropeway with endless rope, at work in the construction of the fortifications of Dantzig.

In making the preliminary survey for an Otto wire ropeway, there are several points to which attention should be paid. The terminal points of the line should, whenever possible, be so placed that the ropeway joining them shall be in a straight line, as each turn increases not only the amount of construction necessary, but also the cost of working, as it necessitates the erection of a complete station. For lines of more than 3½ miles in length, one or more intermediate stations must be erected, as greater lengths than this cannot be worked with one hauling rope. At the stations the line can form any desired angle. The points selected for the supports for the bearing-rope should be marked on the ground by wooden pegs distinctly numbered, and should be shown in the section drawn. The distances between the supports should be 50 yards, when 50 to 100 tons are transported in 10 hours, 40 yards for 100 to 600 tons, and 35 yards for amounts above 600 tons in 10 hours. This rule may be neglected in crossing roads, in which case one support should be at the side of the road, and it may be neglected when this rule would necessitate the support being placed in a narrow valley or hollow, in which case, in order to avoid unneccessary height, the post may be moved. For crossing valleys and rivers, spans of 350 yards may exceptionally be employed, when supports are impossible, or would exceed 35 yards in height. In crossing roads, cross-sections must be made in order to give the requisite data for the erection of a protecting bridge, and cross-sections must be taken at every point selected for a station.

Marshy sites must be avoided as far as possible; but in cases where this is out of the question, the surveyor must determine the

depth to the solid ground. He frequently, too, has other difficulties to contend with. For example, in making the preliminary survey for an Otto wire ropeway in one of the West Indian islands, I found that the work was rendered more complicated by the dense tropical vegetation. It was impossible to see the two ends from any point in the proposed line, and it was consequently necessary first to make a traverse survey, and then to set the

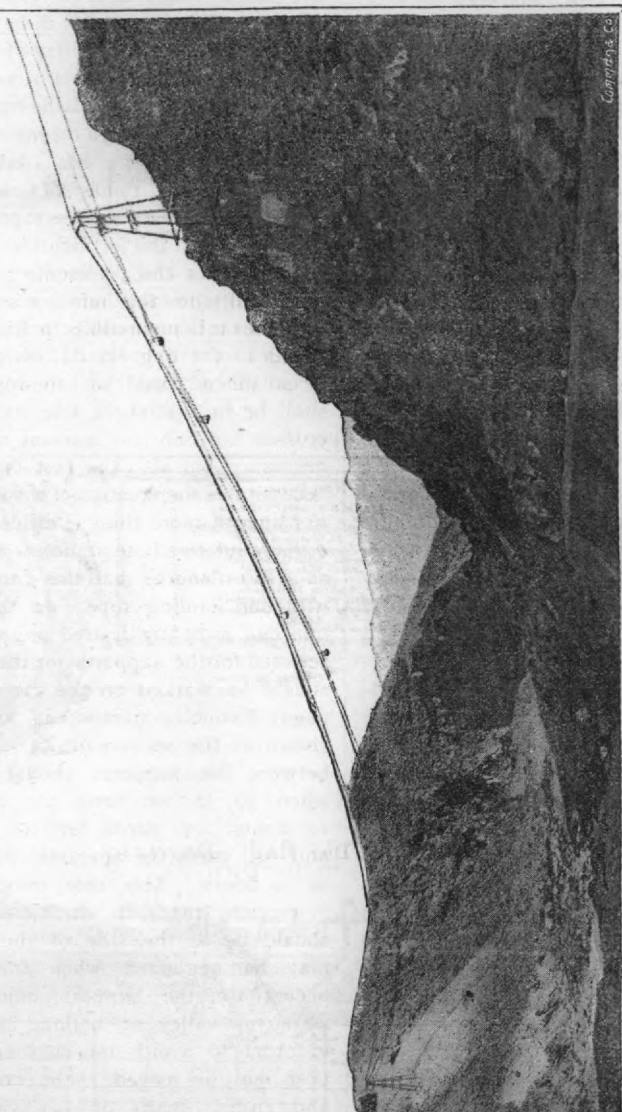


FIG. 16

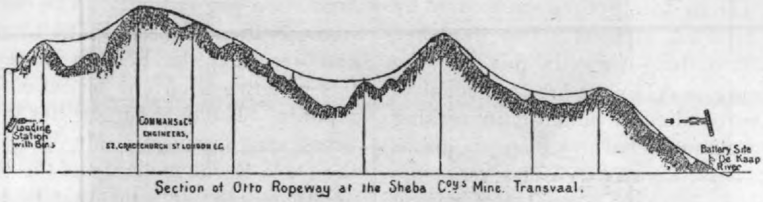
LARGE SPAN, GARRUCHA WIRE ROPEWAY.

line out from the calculated co-ordinates, a path being cut for the line of levels through the jungle.

The hydraulic mining ditches of California afford some interesting examples of levelling successfully conducted in the face of great difficulties. Hydraulic mining consists in the disintegration of auriferous gravel deposits by propelling a heavy jet of water under pressure upon the bank, and in washing the gravel

down through sluices in which mercury is distributed. The gold forms an amalgam, and is thus caught. This method of mining was introduced in California in 1856, although its origin is much older, as Pliny describes a system of hydraulic mining in Spain, which resembled in many respects the modern method. Hydraulic mining has given rise to an extensive system of artificial reservoirs in the Sierra Nevada for the storage of

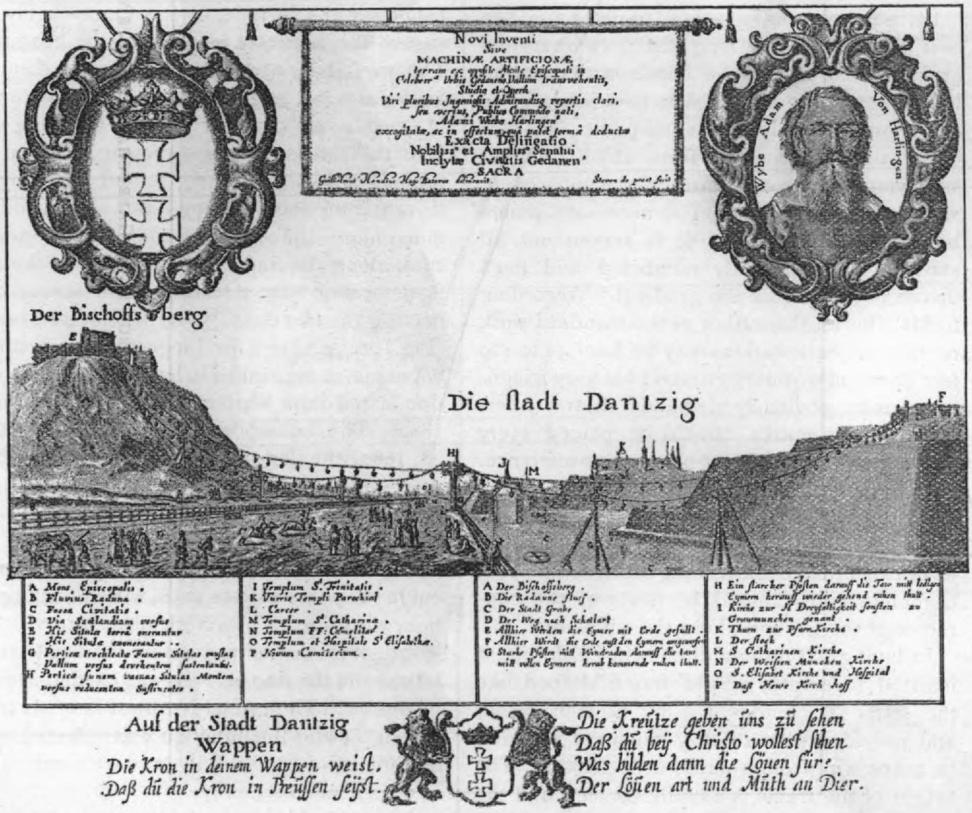
FIG. 17.



Section of Otto Ropeway at the Sheba Coy's Mine. Transvaal.

water, and to the construction of artificial water-courses to convey the water thus stored to the scene of mining operations. The setting out of these canals at a grade of from 4 to 20 feet per mile, over deep gorges and along precipitous cliffs, presents problems of great difficulty to the mine surveyor. In many places it is impossible to find room along the sides of the great cañons for miles to excavate a canal or to rest a conduit or

FIG. 18.



"flume," as it is locally termed. The bracket flume of the Miocene mine is a marvellous example of engineering skill. Here, in order to obviate the erection of a trestle 180 feet in height, the water is conveyed in a wooden flume—4 feet wide and 3 feet deep—round a cliff 350 feet in height. The flume is suspended upon brackets made of T-rails, fixed into holes previously drilled in the vertical cliff. In another place, in the line of this ditch, is a

piece of trestlework 1,088 feet long and 80 feet high. Again, the Blue Tent Mine has a ditch running for a distance of six miles along the face of a cliff, over which the surveyors had to be suspended by ropes 1,000 feet above the bottom of the gorge, in order to establish the line of the flume.

In other places deep gorges are crossed by means of inverted siphons. The Cherokee ditch crosses a deep cañon in this way, the pipe sustaining a columnar pressure equal to 800 feet in perpendicular height. In making the crossing, 12,000 feet of 38-inch pipes, 3-8ths inch in thickness, were used. A few years ago there were in California 6,000 miles of mining ditches, their estimated total cost being £3,000,000. Some of them have been built at a cost of £5,000 per mile. The cost, too, of keeping them in repair is very considerable, as the hydraulic miner has constantly to contend with the elements—frost and flood, ice and snow, wind and rain.

In the preliminary survey, to determine the best situation for a long ditch, comparative observations should be made with aneroid barometers, care being taken to determine the elevations, not only of the end points, but also of intermediate points, from which different surveying parties can start on the subsequent setting out of the line. The necessary points being established, the line is staked out, all stations being properly numbered and pegs driven in to indicate the gradient. According to Mr. Bowie, the author of the standard work on this subject, stations may be from 50 to 100 feet apart on ordinary ground; but very irregular country obviously demands shorter intervals. Bench-marks should be placed every quarter or half a mile for convenient reference. All details of tunnels, cuttings, and depressions, which require pipes or flumes, should be worked out in full, a work in which the hand-level can often be advantageously employed. Complete notes should be made of the character of the ground along the whole line.

In laying out mining ditches in California, it is usual to employ a light frame shaped like the letter **A**, made of $\frac{1}{2}$ by $1\frac{1}{2}$ inch wood, and provided with a heavy plummet hanging on a fine wire from a notch at the apex. The height of the frame is usually six feet, and the base ten feet. To commence, one end is placed on a level piece of ground, and the other end is raised or lowered until both ends are level, and the plumb-line marks the same position on the cross-bar, if turned completely round. The grade for the proposed mining ditch being decided upon, say half an inch in ten feet, a half-inch piece of wood is placed under the rear end of the frame, and the point indicated by the plumb-line is marked on the cross-piece. One man then holds the frame, while another lifts the front end until the plummet coincides with the mark, he then drives in a peg in front. The rear end of the frame is then placed exactly where the front end was, and the process is repeated. In this way the ditch can be set out with great rapidity. The only danger lies in getting the wrong end foremost. Mr. W. J. Sharwood, the De la Beche medallist of the Royal School of Mines, 1887, tells me that he has seen one ditch that was actually dug for three-quarters of a mile, with the apparent object of carrying water up-hill.

In surveying and levelling tunnels, the difficulties encountered by the surveyor are frequently considerable, great care being necessary to transfer the centre line, established on the surface, to the tunnel below, to ensure the accurate meeting of the headings. The work has, of course, to be carried on by artificial light, and the atmosphere in a tunnel in course of construction is anything but favourable to accurate surveying. When the tunnels are of great length, and can only be driven from the two ends, the setting out is much more difficult than when shafts can be sunk along the line. The direction of the axis is determined by a triangulation survey connecting the two ends. The St. Gothard tunnel (Fig. 20, p. 830), the longest railway tunnel yet made, is nine miles in length. Its construction lasted from September, 1872, to February, 1880. The holing was effected on February 28, 1880, the length being 25 feet less than was expected. The error in level was 1·97 inch, and the error in alignment was 12·99 inches.

The Mont Cenis tunnel (Fig. 19, p. 830) was set out in the years 1857 to 1858, without triangulation, with the aid of a high observatory. The length of the tunnel was determined by triangulation, and the line of levels was carried over the mountain. The tunnel is upwards of six miles in length, and the junction was effected without any error horizontally, and with only a foot of divergence vertically.

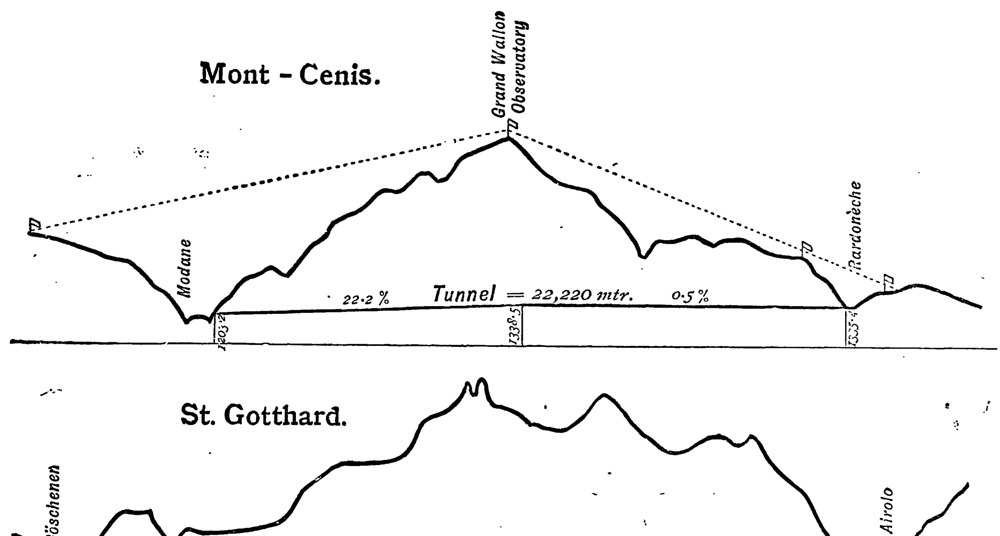
A remarkable example of successful holing was afforded by the Ernst-August adit-level, the great subterranean canal in the Hartz mountains, communicating with a main winding shaft at the dressing-floor, and serving both as a means of transit for the ore, and as

a drainage level for the mines. This great adit, one of the largest in the world, was begun in 1850, and finished on July 22, 1864. It has a total length of 25,956 metres (15½ miles), and was driven from bearings and distances calculated from the results of a survey, made with extreme accuracy by the theodolite and level, the length of theodolite survey for each holing averaging 12,000 feet. The error at the nine holings averaged 9 inches.

Remarkably accurate results in tunnel alignment were recently obtained in the Croton Aqueduct at New York. In one case, the starting points of two headings were 6,400 feet apart, the one 270 feet and the other 353 feet below the surface. The diameter of the heading was 16½ feet. The direction was obtained by means of two plumb lines, 16½ feet apart, let down each shaft. When the two headings approached each other, the final connection was made by two drills meeting in the same hole from opposite sides of the rock, and after the blast had been fired, it was found that the error in level was 0·014 foot, and that in alignment, 0·09 foot.

In the construction of Division No. 6 of this aqueduct, Mr. F. W. Watkins, the engineer in charge, found that the centre-line wires were very difficult to distinguish, as the cross-hair of the telescope and the two plummet lines appear so nearly alike. He was, therefere, induced to devise an illuminated slit apparatus to replace the wires at the bottom of the tunnel. This instrument consists of

FIGS. 19 AND 20.



two vertical strips of brass (3 inches in height) attached to separate horizontal bars moving in guides, and provided with a tangent-screw motion, by which one or both could be moved right or left and the vertical aperture between them made as small as desired. One of these instruments was screwed to a plank-bracket, close behind each plummet wire, and so placed that the farther one could be seen through the telescope in line just above the other. When these slits were adjusted so as to be directly behind the plummet wires, the latter were removed, and lights placed behind the slits. In this way two fixed and illuminated lines were substituted for the wires. The results of tests of the alignment effected in this way show that the accuracy of the surveys was very remarkable.

Taking cross-sections, for measuring the areas and quantities of excavation in tunnel work, is best done by measuring the irregularities of the contour of the section, by angles and distances, from some point in the vertical plane through the axis of the tunnel. For the Croton aqueduct tunnel, where sections had to be made every 10 feet for over 30 miles of tunnel, a convenient instrument was designed by Mr. A. Craven. This instrument, known from its yellow disk of varnished wood as the sunflower instrument, consists of a light wooden tripod

with extensible legs, a shifting top, ball and socket joint, and levelling screws. A vertical brass tube slides through the socket, and carries at its top a wooden graduated disk, 18 inches in diameter. An arm revolving on a central socket traverses the face of the disk, and a wooden measuring rod, 14 feet in length, is placed on this arm, and slid out to touch the surface of the tunnel, the end of the arm at the same time indicating the angle from the vertical. The measuring rod tapers from 2 inches to ½ inch in width, and is graduated in feet and tenths from the smaller end. In order to ensure the cross-section being taken at right angles to the axis of the tunnel, the disk is provided with a small sighting tube perpendicular to its face. The measurements are recorded in the field-book, and the areas of the cross-sections are determined by calculation, or by the planimeter.

When the difficulties of the task are duly considered, it is probable that the accuracy of the work at the Hoosac tunnel has never been equalled. This tunnel passes through the Hoosac Mountain range in Massachesetts, and is 25,031 feet in length. The tunnel was driven from the two ends, and also from a shaft 1,028 feet deep sunk in the valley between two mountains in the line of the tunnel. On the east side, the headings met at a distance of 1,563 feet from the shaft, and 11,274 feet from the eastern end, the lateral error being 0·025 foot, and the vertical error being 0·23 foot at the point of junction. Proceeding westward, the tunnel extended 2,056 feet from the shaft before meeting the excavation on the western side, which was 10,138 feet from the west entrance. The holing showed that the error of alignment was 0·045 foot. The alignment in the central shaft was obtained by two plumb-bobs 25 feet apart.

In New South Wales, a very successful alignment was effected by Mr. T. W. Keele in the construction of the Nepean tunnel, a conduit for supplying Sydney with water. The tunnel is 23,507 feet long, and was driven from six shafts varying in depth from 210 to 324 feet. In each case the error on holing was extremely small, and after the tunnel had been pierced through daylight at one end was distinctly seen without the aid of a telescope from the other 4½ miles away.

Curiously enough, the oldest piece of tunnelling of which there is any written record was begun at the two ends, its construction being recorded in the oldest example of Hebrew writing known. The inscription, now known as the Siloam inscription, was discovered by some boys bathing in the Pool of Siloam, in Jerusalem, in 1880. It is cut on a tablet 27 inches square at the mouth of the tunnel, and, according to the translation of Professor Sayce, reads as follows:—

"[Behold] the excavation! Now this is the story of the tunnel: While the miners were still lifting up the pick towards each other, and while there were yet three cubits [to be broken], the voice of one called to his neighbour, for there was an excess in the rock on the right. They rose up—they struck on the west of the tunnel; the miners struck each to meet the other pick to pick. And there flowed the waters from their outlet to the Pool for a thousand two hundred cubits, and [three-quarters] of a cubit was the height of the rock over the heads of the miners."

From this inscription, it is evident that the tunnel was begun from the two ends. And this view is confirmed by the results of recent explorations. The Pool of Siloam is supplied with water from the so-called Spring of the Virgin, the only natural spring near Jerusalem, by this tunnel driven in the rock. According to Major Conder's survey, the tunnel is 1,708 feet long, or about 1,200 cubits of 18 inches. It does not, however, run in a straight line, and towards the centre there are two *culs-de-sac*, of which the inscription offers an explanation. We thus see that the engineering skill of the day was by no means despicable. Like the Mont Cenis tunnel, this aqueduct was begun simultaneously at the two ends, and, in spite of its windings, the workmen almost succeeded in meeting at the middle. They approached, indeed, so nearly to one another that the noise made by the picks of one party of miners was heard by the other, and the parting of rock was accordingly holed. This accounts for the two false cuttings now found at the centre of the tunnel, these representing the extreme points reached by the two parties before they had discovered that instead of meeting they were passing one another.

Though the inscription contains no indication of date, Professor Sayce is of opinion that the tunnel was made in the reign of Hezekiah, or possibly even in the time of Solomon.

With regard to the interpretation of the last line of the inscription that "three quarters of a cubit was the height of the rock over the heads of the miners," it is remarkable that the difference of height of the two channels at the point of junction is just 13 inches, or close upon three-quarters of a cubit. Unfortunately, however, the text is deficient just in the place

where the number occurs, and it may possibly indicate that the miners knew the thickness of the rock above them. In this case, the correct interpretation is probably 100 cubits, the average thickness of rock above the aqueduct. Several marks, evidently artificial, were discovered by Major Conder in the tunnel—square or triangular notches, measuring 1½ inches in width. These appear to have been used, like the peg and nail of the Cornish miner, to mark the end of a periodical survey, or else to serve as a guide in setting the contracts to the miner.

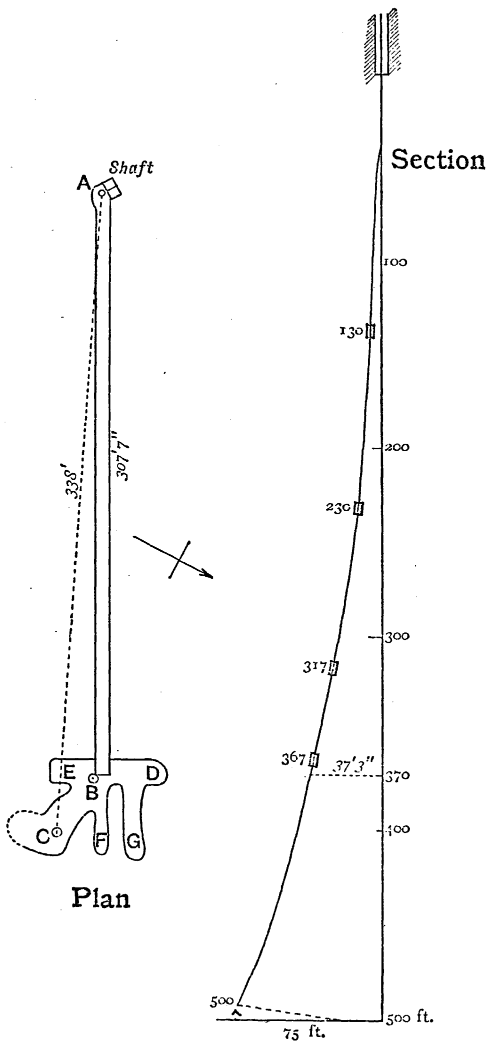
It is certainly remarkable that there should have been so slight a difference in level between the two portions of the tunnel. It would have been easy, by means of a plumb-line or a rude water-level, to preserve the level of the channel floor; but it is extraordinary that the two ends should differ by only a foot in level, considering that they were started independently.

Thus far we have considered the mapping of underground excavations that are accessible to the mine-surveyor. In exceptional cases, however, he is called upon to map excavations that are inaccessible; for instance, when it is required to ascertain the deviations in bore-holes. It has been assumed that the diamond drill always bores a vertical hole, even though passing through rocks of different hardness. Actual experience reveals an entirely different state of things, the deviations being sometimes so great as to render a bore-hole misleading.

A simple and effective method of surveying a bore-hole has been devised by Mr. E. F. Macgeorge, an Australian engineer. Clear glass phials, nearly filled with a hot solution of gelatine, and each containing a magnetic needle and a plummet in suspension, are encased in a brass protecting tube, and let down to the depth required. After remaining for several hours until the gelatine sets, the phials are withdrawn, and can each be replaced at the same angle as that at which they cooled by means of the congealed surface seen through the sides of the phial. Revolving the phial upon the part where the magnetic needle is seen embedded in the gelatine, until the needle is again in the meridian, obviously brings the phial to the same position as it had when its contents congealed. Thus the gradient and bearing of the borehole can be determined at measured intervals throughout its length. The recording instrument is somewhat similar to a theodolite, so arranged that, when the phial is placed in it, and adjusted by means of the imprisoned plummet and magnetic needle until it assumes the same position, both as regards inclination and azimuth, as it did in the borehole, the bearing can then be read off.

The invention was applied at the Scotchman's United Mine, at Stawell in Victoria,

FIG. 21 AND 22.



where the bore-hole was completely lost, huge chambers being cut in various directions before the bore-hole was finally found, by Macgeorge's method, nearly 40 feet away from its proper position. In the plan of the workings shown in Fig. 21, AB represents the exploratory level that failed to find the bore-hole at B—its theoretical position if the drill had gone straight. The subsequent

exploratory workings, BF, BD, BE, DG, were galleries 15 to 30 feet wide, and the miners were working hopelessly at G when Macgeorge's method was applied, and the bore-hole found at C, $37\frac{1}{2}$ feet away from its theoretical position, in a contrary direction to all previous workings. The explorations lasted twelve months, and cost £3,663. Had Macgeorge's method been applied before beginning the long level, it would have been merely necessary to direct the level along the line AC. The saving thereby would have been no less than £2,311. The section (Fig. 22, p. 832) shows the theoretical and actual paths of the drill; the deflection at 500 feet would be as much as 75 feet. Similar deviations have also been met with in other mining districts in Australia; several cases are recorded in the recently published report of the Royal Commission on the gold resources of Victoria. And it is probable that similar deviations are encountered in all districts where deep bore-holes are used.

A less satisfactory method of surveying bore-holes was adopted by Mr. G. Nolten (British patent, 1891, No. 4371). In the instrument employed for this purpose, the amount of deviation is etched upon glass by hydrofluoric acid, whilst its direction is found by means of a compass needle, clamped by the aid of a stop-watch, after sufficient time has been allowed for settling.

In these lectures I have attempted to trace the history of mine-surveying, to briefly describe to you the instruments used, and to give you some examples of mine-surveying practice. It must, however, be borne in mind that the mere listening to lectures or reading of text-books will never make a mine surveyor, The mechanical manipulation of the instruments can only be learnt under the personal supervision of a teacher, whilst the requisite skill for carrying out subterranean surveys must be obtained in the mine itself. Even by a skilled surveyor, no opportunity of testing the accuracy of his work should be neglected, and the first thing the beginner has to learn is to get rid of any trace of belief in his own infallibility.

In illustration of this lecture, Messrs. J. Davis and Son exhibited an 18-inch dumpy level with Hoffman joint, Jee's levelling staff, Louis's clinometer in aluminium, and a surveying aneroid. Mr. W. F. Stanley exhibited a large collection of improved dumpy levels, a mine levelling-staff, an Abney hand-level, and a surveying aneroid.

Miscellaneous.

THE TEAK FORESTS OF NORTHERN SIAM.

The Acting Vice-Consul at Bangkok, in his report just issued, says that the effect of the indiscriminate working and absence of conservancy is beginning to be very evident in the teak forests of Chiengmai and Lakhon. Teak saplings are cut down in large numbers for house posts, and even for making fences, and the clause in the leases forbidding the felling of small trees is disregarded. The consequence is, that in Chiengmai there is reason to fear that in five years' time the only teak left will be that which is too far from the water to be profitably worked; and in Lakhon the foresters complain that all the best trees have already been felled. The merchants who work teak in the Më Yom complain very much of the timber-stealing which goes on at Sawankalôk, the rafting station on that river. The stolen logs are often fired with kerosene to deface the hammer marks of the owners—the authorities do not appear to do much to keep the thieves in check. The present system of granting forest leases for three years only is very prejudicial to the interests of foresters. In many cases the leases are renewed when they expire, but a forester who is not fortunate enough to secure a renewal of his lease, may find that at the end of three years his logs are still lying in the forest, as it takes at least three years—generally much longer—from the time a teak tree is girdled, to fell the tree, lop off the branches, and drag and float the log out of the forest; and if the wording of the lease is strictly adhered to, all logs lying in the forests, and girdled trees, become the property of the owner of the forest as soon as the lease expires. Under these circumstances, a forester taking up a new lease is not likely to girdle many fresh trees, but will only fell the trees already girdled, and the lease being granted for such a short period he is not encouraged to make a large outlay of capital and labour in the first. Previous to the year 1888, the leases granted to British subjects were generally for a term of six years, but in that year the time was reduced to three years. This change was, it is said, due to the action of the Siamese Commissioners, by whom forest leases are ratified. The greater part of the capital with which the teak trade of the district of Northern Siam is carried on is British, and there are now three British firms engaged in the trade which have branches in Chiengmai or Lakhon, the Bombay-Burma Trading Corporation having established a branch at Lakhon in 1891. The Chiengmai forests on the Salween side are worked almost entirely with British-Indian capital brought from Maulmain. Some squared logs of teak are this year to be sent from Chiengmai to Bangkok as an experiment. The logs

are roughly squared in the forest before being put in the river, the advantages of sending such squared logs being that there is less weight to be dragged to water, payment of duty on the valueless part of the log is avoided, and the logs obtained are all sound. The axes used for felling teak have an iron head measuring ten inches by two inches. These axe heads were until recently all of native manufacture, but some of them are now imported from England.

INCREASE OF PUBLIC WEALTH IN PRUSSIA.

According to the tax-rolls of Prussia, the total population, in 1876, was 24,832,784, while in 1890 it was 29,087,933; there was thus an increase in population of 17·1 per cent., but the United States Commercial Agent at Mayence says that the number of persons in the population paying income-tax on incomes exceeding £150 increased 64·2 per cent.—from 571,975 to 939,072 persons—having risen from 2·3 per cent. of the entire population in 1876, to 2·9 per cent. in 1889. The total amount of tax derived from such incomes advanced from £1,552,727 in 1876, to £2,492,437 in 1889, or about 60 per cent., making an average annual gain of about 4·3 per cent. At the same time the number of persons entirely exempted from taxation of income increased nearly 16,000,000. In 1876 the number of persons exempted amounted to 6,369,836, or 26 per cent. of the population; in 1890, to 22,318,273, or 77 per cent., through extension of the amount exempted. The exemption is of all incomes under £45, but up to 1883 the exemption was only of those under £21. Prussia, during the years comprised between 1876 and 1890, has been growing in wealth and numbers, and the wages and salaries of its working population have in general experienced an increase, though counterbalanced, to some extent, by enhanced prices for the necessaries of life. The people of Prussia, in recent years, have taken a very large amount of German and other bonds and securities, through some of which heavy loss has been sustained, but, on the whole, they have been a source of profit and income to their holders. However that may be, the United States Commercial Agent says it cannot be denied that there has been an increase of the incomes of the Prussian people, taken altogether, since 1876, and especially of the wealthy classes. The number of persons in Prussia having taxable incomes amounted, in 1890, to 10,207,892, of which 6,769,660, or 23 per cent. of the population, were taxed. The taxable population, in 1876, was 8,467,076. By taxable population is meant, not subject to tax, but having incomes upon which the Legislature might impose taxes. The average income of an ordinary toiler in Prussia is estimated at £17 10s., and at £25 as the average income of a labouring household, which figures are said to be a mean computation between the highest and lowest estimates for this class of the population. The number of persons in Prussia enjoying an income of from £300 to £1,000 a year increased from 58,286 in 1876, to 91,512 in 1890, or 57 per cent., and the sum total of their incomes from £28,000,000 to £44,000,000, or a proportion of 60 per cent. In the case of incomes of from £1,000 to £5,000, the number of taxpayers increased from 7,501 in 1876, to 12,521 in 1890, and their aggregate incomes from £14,000,000 to £24,000,000, or about 66 per cent. The number of persons with incomes exceeding £5,000 rose from 532 in 1876, with an estimated aggregate income of £5,650,000, to 1,062 in 1890, with one of £11,000,000, or nearly double. The incomes from £100 to £300 also increased considerably during the period in question, but not in the same ratio as the larger ones. The number of persons estimated in 1876 to have an income of from £100 to £300 amounted to 384,248, with an aggregate income of £61,000,000, or £158 per head; in 1890, to 490,541, with £80,000,000 income, or £162 per head. Among this class of the population the increase in the number of taxpayers was 28 per cent., and in incomes 30 per cent., thus much behind the augmentation in the greater incomes. There has been a stricter estimate of incomes in Prussia in recent years, especially of the larger incomes, which fact swells the statistics to some extent, but an increase of general wealth has, it is said, been a still greater factor. This factor is better shown by the kingdom of Saxony, where everyone is required, under severe penalty for false declaration, to state his income. According to the official statistics of Saxony, the number of people assessed, and the aggregate amount of incomes in 1879 and 1888, were as follows:—Number of persons assessed in 1879, 1,088,002; in 1888, 1,327,771; aggregate income in 1879, £48,000,000, and in 1888, £67,000,000; average income per head of population £16 in 1879, and £20 in 1888. The number of income taxpayers has therefore increased 22 per cent., and the total amount of their income 40 per cent. in Saxony during the ten years ending with 1888. In Saxony, 40 per cent. of the population pay income tax. Everyone there with an annual income of £15 is subject to income tax. In Prussia all incomes under £45 are exempt for taxation. Prussia, in 1890, showed thirteen persons having an estimated income of over £50,000 each, and Saxony only one. The exhibits of the savings banks also show a general augmentation of the wealth of the people, and since 1875, the number of accounts open and the sums deposited have doubled.

THE FORESTS OF BRITISH INDIA.

The forest lands of India belong chiefly to the State, except in parts of Lower Bengal. It is stated

in a report recently issued by the India-office that the efforts of the Forest Department are directed to selecting the best and most remunerative forest areas as reserves, to conserving them and securing reproduction of timber and firewood, and to working the produce of the reserves to the best advantage. Outside the reserves there are in some provinces very large forest or waste areas which are accessible to the people and can be reclaimed for cultivation when need arrives. The reserves, however, will always be retained as State forests, to be conserved and worked according to the best principles of scientific forestry, for the use of the neighbouring populations and the advantage of the public treasury. The Forest Department is manned by European officers, who have been trained at forest schools in Germany and France, or at Cooper's Hill College, and also by Indian and other officials trained in the forests or at the Indian Forest School established at Dehra in the North-West Provinces. Timber, firewood, and other forest produce in the reserves are worked out in rotation, or on other scientific principles, so as to prevent exhaustion of the supply. Natural reproduction is safeguarded by the exclusion of the yearly fires which used to devastate most Indian forests; and artificial reproduction is effected by systematic plantations. Forest revenue is raised by selling or giving permits for timber, for firewood, for charcoal, for bamboos, for grazing, or for older minor forest produce, with due regard to the claims and comfort of neighbouring rural populations. The extensive State forests and wastes outside the reserves are worked so as to produce revenue and to meet local demands, with such rough and inexpensive conservancy as may be practicable. Private forests, wherever demand for timber exists, are being worked with little regard to reproduction; and this circumstance makes the careful conservancy of public forest property all the more important. Forest conservation began in some parts of India more than forty years ago, but systematic conservancy under regular forest laws began under the forest administration of Dr. (now Sir Dietrich) Brandis, about the year 1862. There are now in British India about 64,000 square miles of reserved forests, of which 6,000 square miles were reserved during the year 1890-91; there is also an area of about 50,000 or 60,000 square miles of other State forest, parts of which may hereafter be reserved, but Madras and Burma are the only provinces in which further extensive reservations are likely to be made. Most of these reserves have been properly demarcated, and in all of them full investigation and settlement of private rights have been completed, or are in progress. Systematic fire protection was, in 1890-91, carried out over varying proportions of the reserved forests in the several provinces, with the result that fire was absolutely excluded from more than 95 per cent. of the protected area in all provinces except Bombay and Burma. Regular plantations of the best timber-bearing trees cover 95,000 acres, of which 4,200 acres were added during the year 1890-91. The total forest revenue of British India was Rx. 1,448,000 in 1890-91, against an expenditure of Rx. 784,000, leaving a surplus of Rx. 664,000 as compared with a surplus of Rx. 706,000 in the preceding year. The chief surplus provinces were Burma and Bombay. The reduction of the surplus was due to a decrease of revenue in Burma, and to a small increase in the cost of the forest staff. About one half of the gross revenue was yielded by timber operations, and the remainder by firewood, charcoal, grazing dues, bamboos, rubber, and other minor forest produce. A large quantity of teak timber and cutch (a substance extracted from the heartwood of the acacia catechu, and used for tanning, dyeing, and for preserving nets) is sent from Burma to Europe; and small, but increasing, quantities of rubber, of forest gums and fibres, of bamboo canes, and of wild silk, are exported from India. The great bulk, however, of the yield of the forests is consumed, and most of the forest revenue is paid, by the people of India.

MANUFACTURE OF SILK FROM WOOD PULP.

The United States Consul at St. Etienne says that the reported failure of the silk crop in France, Italy, and Syria has again directed the attention of some of the most important manufacturers of St. Etienne to the process invented by Count Chardonner for the manufacture of silk from wood pulp by a method similar in principle to that employed for converting wood into paper. A few years ago the new invention was brought out, and the rights to its exclusive use were sold to companies in Germany, France, and England. Large works were built at Besançon, and preparations for manufacturing silk from wood were projected and made on a somewhat extravagant scale. Some remarkable specimens of silk made by this process were shown, but it was found that the fabric so manufactured could not be woven successfully in large pieces, and that it was of so highly inflammable a nature as to be a source of great danger. The experiments were then dropped, and nothing was heard of the matter until a few months ago, when a company was organised at St. Etienne to develop the process of Count Chardonner and make it a thoroughly practical one. This company is quietly at work now, and is making a large number of experiments which, Consul Loomis says he has been informed by those in a position to know, are likely to lead to some important and satisfactory results. It is affirmed that in a short time the company will be able to offer to the trade a substitute for silk which will possess all the essential qualities of silk, and which can be sold for less than half the cost of the genuine article.

FIBRE AND FRUIT CULTIVATION IN THE BAHAMAS.

In a recent report by Sir Ambrose Shea, Governor of the Bahamas, it is stated that fibre cultivation makes very satisfactory progress in the colony, and there are now about 8,000 acres planted out, and it is expected that at least 6,000 acres will be added during the present year. A larger addition would be made, but that the supply of plants of the requisite growth is as yet limited. It is now ascertained that it is not advisable to transplant from the nurseries until they are at least one year old, and have attained a length of twelve or fifteen inches. It is anticipated that the export from early plantings will amount to about a hundred and fifty or two hundred tons in 1892, and this quantity will probably increase, but an estimate shows that it will not reach beyond 14,000 to 15,000 tons up to the year 1900. It is now ascertained that with plants of fair growth four years is the longest time for the maturing of the plant, and it then yields an annual crop, without further care for twelve or fourteen years. The available supply of fibre at present is not more than is required for the needs of the colony, which would be hampered by outside demand, and the progress of the colony be consequently retarded. It would be difficult, it is said, to assign a limit to the future advance of the colony from the growth of this remarkable industry. Though the land provisionally assigned to fibre cultivation (100,000 acres) will in time yield 50,000 tons, there appears to be no reason why even this great result should bar the extension of the area of production, if the markets admit of its profitable disposal. It is generally thought that, from the excellence of the fibre, it will find its way into other fields for its use besides rope-making; and recent experiments prove that it takes a dye readily, indicating its adaptability to certain fabrics, and to some extension of demand on this account. There is the further ground for the probably strong place for Bahamas' hemp in the future, that it can be produced more cheaply than any known fibre of equal value, and it may be inferred that it will hold its own at least against the influence of any probable competition with which it may have to contend. As regards fruit-growing, the Bahamas offer very great facilities. Pineapples are at present the principal crop, but the particular description of land required for their culture is very limited. Of late years the growth has been much improved by the use of fertilisers, with a considerable increase of quantity. The crop yields large profits. At twopence each, an acre of pineapples returns £40 to £45; and although precarious from its perishable nature, while such results are possible, it is likely that pineapple-growing will continue to be an attractive pursuit. In oranges a good business, it is said, might be done, if the accounts of Florida enterprise in this fruit are a fair criterion. At present the oranges of the Bahamas are roughly handled, being generally shipped in bulk in the holds of vessels, often without compartments. The fruit is held to be equal to any in the world, and as at present it receives little or no attention, the result of careful cultivation could not fail to be remunerative. The facilities for production are fully equal to those in Florida, and the Bahamas are entirely free from all risk of frost, which so often blights the Florida crop. The success of the industry in the colony would be partial, however, until the proper system of packing were adopted to ensure delivery at market in good condition; with this point secured, and the advantages of steam communication, which is fast becoming available, orange growing would be a profitable industry. Tomatoes are grown to a moderate extent, but the production, it is said, might be largely increased. Sir A. Shea says that it is to be regretted that, of the many young Englishmen who embarked in orange growing in Florida with chequered results, and of those also who sought their fortunes in South America, some, at least, had not found their way to the Bahamas, where energy and thrift, applied to the varied resources, can hardly fail to reward well-directed efforts, and where personal rights and property are under the protection of British laws and administration.

General Notes.

CHICAGO EXHIBITION.—Mme. Carnot has accepted the presidency of the committee, whose business it will be to organise the French exhibits in the section of women's work at the Chicago Exhibition, and the members of which are:—Mme. G. Berger, Mme. Bertault, Mme. Bagelot, Mme. Brouardel, Mme. Miolan Carvalho, Comtesse H. de Chaiseul, Mlle. d'Eichthal, the Générale Février, Comtesse Foucher de Careil, Comtesse de Grandval, Comtesse Greffulhe, Mme. Coralie Cohen, Mme. Kœchlin-Schwartz, Mme. Madeleine Lemaire, Mlle. Laiziblen, Mme. Lourdelet, Mme. H. Mallett, Comtesse de Montsaulnin, and the Marquise de Moustier. Their meetings are to be held at the Palace of the Elysée.—*The Queen*.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, AUGUST 5, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of the Fine Arts Committee was held on Tuesday, 2nd inst. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, Pres. R.I.B.A., Wyke Bayliss, Pres. R.S. Brit. Artists, Philip H. Calderon, R.A., H. Stacey Marks, R.A., Deputy-President R.S.P.W.C., Walter William Ouless, R.A., Marcus Stone, R.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

REPORT ON A VISIT TO CHICAGO, JUNE, 1892, BY THE SECRETARY, [redacted] HENRY [redacted]

In accordance with the instructions of the Commission, I left England on the 15th June, and arrived in Chicago on the 25th June, having made a stay of two days in New York.

I crossed in the *City of Paris*, of the Inman Line, and I think I ought to express my appreciation of the accommodation which that company afforded me, on both the outward and the homeward voyage. Both voyages were illustrations of the luxurious and comfortable manner in which it is now possible to cross the Atlantic in the ships of this and of the other great steamship lines.

I have also to express my obligation to the New York Central Railroad authorities, who favoured me with a free pass over their line. on going to and returning from Chicago. When Mr. Dredge and I visited America last autumn, we were the subjects of equal kindness and attention on the part of the Pennsylvania Railroad, and that company kindly offered similar liberal treatment to myself on the present occasion. I was, however, anxious to get the fullest information as to the various routes from New York to Chicago, and therefore preferred to avail myself of the kindness of the New York Central. On either line the journey is now made in 25 hours, by two express trains daily in either direction, leaving New York and Chicago respectively in the afternoon and evening. Both trains are fitted in the most luxurious manner; and it is no exaggeration to say that the journey is made with no greater discomfort than that of remaining in a well-furnished hotel. It, indeed, involves less tedium than an ordinary journey of 300 or 400 miles in this country.

Visitors who desire to see Philadelphia and Washington will prefer the Pennsylvania line; those who care to break their journey at Niagara will take the New York Central. Both lines pass through fine scenery: the Pennsylvania crosses the Alleghanies, while the New York Central runs by the side of the Hudson, and through the Mohawk Valley. With regard to the comfort of the journey, there is little to choose between them. The New York Central has the advantage—to English notions—that, if privacy is desired, separate small rooms can be obtained, fitted [redacted] for the accommodation of one or two [redacted]engers.

On arriving at Chicago, I was met by Colonel Grover, R.E., who had been there since the 6th May last, in charge of the arrangements for the erection of the building for the British Section. I should like to take this opportunity of expressing my appreciation of that gentleman's services. I shall refer to the progress which has been made in the construction of the building later on; but I may say here that Colonel Grover has been untiring in his devotion to the interests of the Commission. Not only has he taken great pains in carrying out their wishes with regard to the building, but he has also rendered valuable services in regard to many other details of the Exhibition work.

I cannot let this opportunity pass without reference to the kindly and generous manner in which the demands of the Commission have on all occasions been met. In every building in which we are exhibiting Great Britain has been assigned a prominent and advantageous

* As presented to the Royal Commission, this report contained detailed information on various matters of a more or less confidential character, and on matters of organisation not of special interest. The passages relating to such subjects have been omitted.

position. Had the Commission been allowed to select for itself the various allotments it could hardly have selected better positions than those voluntarily assigned to it. Where all the officials have shown themselves so helpful, it seems almost invidious to particularise. Yet I cannot abstain from expressing my sense of the value of the services rendered by Colonel Davis and Mr. Baker, the heads of the two important organisations by which the Exhibition is controlled, by Mr. Burnham, the Chief of Construction, and by Mr. Fearn, the Chief of the Foreign Sections. All the official correspondence with the Commission has been conducted by the last-named gentleman, and it has throughout been of the most friendly and pleasant character.

Condition of the Buildings.

One of my first duties was to visit Jackson-park, and see the progress which had been made in the buildings there. Very great advance has been made since my visit in September last, quite sufficient I should say to justify the belief that the buildings will be completed, though not ready for the reception of exhibits, by the date of the inauguration ceremonies in October.

The buildings are in various stages of completion. The most backward is the great Manufactures Building. This, I was informed, has been delayed by the necessary materials not being all ready for delivery by the appointed date, but even it is very far advanc[illegible] Seventeen of the twenty-three great roof trus[illegible] of the main structure were in position before I left Chicago, and the remainder will doubtless be set up by the end of this month.

On the other hand, some of the buildings are practically completed. The Mines Building is quite finished, except as to the interior decoration. This, it appears to me, is the building best suited of any for exhibition purposes; for, its roof being constructed on the cantilever principle, there is no necessity for the supporting pillars which, in many of the other buildings, occupy a large amount of space. This is especially the case in the Agricultural Building, the galleries in which are very extensive, and in consequence, the ground floor space is very much obstructed by numerous supporting pillars. The general effect of the whole will, I think, be a good deal impaired in consequence. On the other hand, the large area of the gallery gives a great deal of exhibition space, and as access to the gallery is obtained direct by the Elevated Railway which runs through the grounds, the galleries are more accessible to, and will doubtless be more visited by, the public than is usually the case at Exhibitions. This building is in an advanced stage of completion, being roofed in, and the exterior nearly completed. The same remarks as to gallery apply, to a large extent, to the Transportation Building. This also is roofed in, but is not quite so far advanced as the Agricultural Building. The gallery in this appears to me to be the best exhibiting space in the building, having regard to the fact that it also is accessible direct from the Elevated Railway. The large annexe to the building has not yet been commenced. This, however, will consist practically of shedding only, so that it can be run up in a very short time.

The Machinery and Electricity Buildings were not so far advanced. The scaffolding being still up, it was not possible to form so good an idea of what their internal appearance will be when completed.

The Horticultural Building is completed outside, and partly finished within; indeed, some of the conservatories are already heated for the reception of plants.

The shell of the Forestry Building has been finished for some time. It is now used as a workshop for the moulders, who are making ornamental statuary in "staff," or fibrous plaster, for the exterior of the buildings.

The Fisheries Building is externally com-[illegible] and the construction of the aquaria and [illegible] with. This is one of the most original and attractive buildings on the grounds. Its style is generally Spanish Romanesque; the arches, capitals, and shafts of the columns are decorated with figures of marine animals and plants, treated somewhat in the same way as the animals which compose the terra-cotta decoration of the Natural History Museum in London.

The walls of the Fine Art Building are built, but the roof is not completed; still, I was able to form a good idea of what the structure will be like when completed. It seems to be admirably suited for its purpose; the rooms will be spacious, and promise to be well lighted, and the arrangements are such that they are all easily accessible from one another, and from the Central Hall. I should think that large crowds could pass through the building without inconvenience. Had the Exhibition Executive realised, in the first instance, how large would be the contributions to this department from foreign countries,

they would probably have designed a larger building at the outset. The two annexes have not yet been commenced.

The Women's Building is practically finished; it is of rather plainer and more unpretentious character than most of the other buildings. It consists of a central hall with rooms opening out of it on the ground floor, and rooms above on the second storey opening into the gallery surrounding the hall. A portion of the roof, I understand, is to be laid out as a garden and restaurant. From it one of the finest views of the park will be obtained.

It is now quite possible to judge what the general aspect of the park will be when the buildings are complete, and there seems no reason to doubt that the high anticipation formed from the design, as to the effect of the magnificent buildings surrounding the lagoons which have been formed in the centre of the park, will be fully realised, and that the general effect will compare not unfavourably with that of the Paris Exhibition of 1889. Having regard to the size and extent of the buildings, it can hardly be expected that they will be more splendid and imposing, as being on a larger scale, than even that presented by the Champ de Mars.

The principal means of access to Jackson-park is, at present, the Illinois Central Railroad, which runs trains at short intervals from its station in the centre of the city to Jackson-park, the journey occupying about 30 minutes. In addition to this there is a service of c[illegible] cars which is being improved and developed in view of the Exhibition, and there has also been recently constructed an Elevated Railroad. This is now at work for some distance from the centre of the city to the suburbs, and is being carried on to Jackson-park. Access can also be had by the lake steamers. A new and special service of these is being organised for next year. These steamers will form a very pleasant but less speedy means of reaching the park than the railroads. At present the tracks of the Illinois Central Railway run by the side of the park on the level, but works have been designed and are on the point of commencement, for raising the track along the whole length of Jackson-park. This is a very necessary undertaking, as otherwise the crowds arriving by car or vehicle from the city would have to cross, on the level, the whole of the lines of this important railroad, one of the greatest leading into the city.

In consideration of the size of the park it has been thought well to make special arrangements for the conveyance of visitors from point to point within it. For this purpose a special service of launches (steam or electric) is being organised for the lagoons and canals which form so special a feature of the grounds, and there will also be an "intra-mural" elevated railway extending from one end to the other of the Park, and arranged so as to convey visitors to the principal points of interest.

Pricing Exhibits.

On Monday morning I called on Colonel Davis, Mr. Baker, and other principal officers of the Exposition, and took this the earliest opportunity of bringing before Colonel Davis the question of pricing the exhibits. Mr. Medill, the proprietor of the *Chicago Tribune* newspaper, came in with a telegram on the same subject from Mr. McCormick, as I was on my way to Colonel Davis's offices, and we saw that gentleman together. The question once raised was promptly settled in the simplest and most satisfactory manner. Colonel Davis at once frankly stated that the writing of the letter which he had signed to the Acting-Secretary of State had been a mistake. He said that his views on the subject had never varied from what he had verbally stated last September, and had since confirmed in the letter written by Mr. Fearn, on the 11th December last, I asked him to refer to my letter to Mr. Fearn, of the 28th November; this he did, and he stated that it distinctly and accurately [illegible] conditions under which exhibitors would be allowed to mark their goods. He further stated that he would at once write to the Secretary of State, explaining that his previous communication had been in error and withdrawing it. This he afterwards did, and a copy of his communication will be found in Appendix No. I. I also took this opportunity of bringing a copy of the resolution passed by the Commission on the 14th June last with regard to Mr. McCormick, and suggested that it might at once be transmitted to the newspapers for publication.

Colonial Allotments.

A matter to which I devoted a good deal of attention was that of the Colonial allotments.

The Hon. J. J. Grinlinton, the Commissioner for Ceylon, had been in Chicago for some little time before I went there, and remained during my stay, returning to England with me. By his able and energetic advocacy of the claims of the colony, he had succeeded

in obtaining very advantageous allotments for it.

The principal object of the Ceylon Commission is to bring Ceylon tea prominently before the American public, and the arrangements which Mr. Grinlinton was successful in making may be expected to effect the object in view.

At my request Mr. Grinlinton has kindly furnished me with a report on his proceedings, which I have added as an appendix to this report. (Appendix No. II.)

Mr. Saunders, the Commissioner for Canada, was in Chicago when I arrived, and was good enough to extend his stay there a few days, that we might have the benefit of discussing matters.

Mr. Berliner, the resident Commissioner for the Cape, visited Chicago during my stay, and Mr. Hutchinson, a Member of the New South Wales Commission, was also there for a short time. I was thus able to discuss with all these gentlemen the requirements of their respective colonies.

In the Manufactures Building I was able to secure a small further addition to the space assigned to Great Britain and the Colonies.

In the Agricultural Building I felt justified in giving up as much as it seemed possible to spare of the space to the Colonies, on condition of a little addition to the total being made, and of a space in the grounds being allotted for the exhibits of bakery machinery in action.

In the Mines Building, also, the total space was extended by about 2,000 feet.

In all cases, the British and Colonial allotments are contiguous, this arrangement being desired quite as strongly by the Colonial representatives as by the Royal Commission.

The total space allotted to the Colonies is over 110,000 square feet; and there is still a portion yet undisposed of in the Manufactures Building. The total space available for exhibits from the United Kingdom is over 220,000 square feet. To this must be added a considerable amount of space in the grounds for the various outside exhibits, perhaps 14,000 or 16,000 more. When all these are added together, it will be found that the total area is not far short of the largest ever occupied by this country at any foreign exhibition—viz., 360,000 in Paris, 1878.

India.

Much disappointment was felt at the absence of an Indian Section, and even now, though it is too late for space in the buildings to be allotted, I believe the Executive would willingly provide a location in the grounds for an Indian building, could one be provided.

At the request of the London Committee of the India Tea Planters' Association, I secured for that body the promise of a space in the grounds on which to erect a building for the exhibition and sale of Indian tea, and I hope that arrangements may be satisfactorily made for the representation of, at all events, this one article of Indian commerce.

Offices of the Royal Commission.

For the erection of the British Pavilion a contract has been entered into with the George A. Fuller Company, of Chicago. This company (who are architects and engineers as well as builders) are perhaps the leading firm in the city, and have constructed many of the enormous buildings for which Chicago is remarkable. They were recommended to the Commission by Mr. Burnham, the Chief of Construction, who has throughout shown much interest in the work of the British Section, and whose kind advice has in this special matter been of the greatest assistance to the Commission.

Under the care of Colonel Grover, R.E., whose services for this special duty the Commission wore fortunate in being able to secure, all the preliminary arrangements for the construction of the building have been made, and the building itself commenced. The foundations are in and the walls carried above the [illegible] of the ground. More than this it was not possible to do until the terra-cotta, as designed by Colonel Edis, the honorary architect, had been prepared. This is now being made in Chicago, and as soon as it is ready the construction of the building will be continued, so that at all events the shell of the house may be completed before the winter.

The example of the Royal Commission in erecting a special building for their offices has been followed by the Commissions for Germany, France, and Canada. The British building, however, is the only one which has been commenced.

The design of the house has been greatly admired, and it may be hoped that its solid and genuine character may not be without a good effect among a mass of buildings which, however imposing in character, are of course of a purely temporary character.

There seems every reason to believe that the building may be sold for a price which will cover at all events a proportion of the cost. Colonel Edis has designed it with this end in

view, and in putting it up the necessity for its ultimate removal will be borne in mind.

Electric Lighting.

I made inquiries as to the arrangements for electric lighting, and ascertained that a small amount both of arc and incandescent lighting is being retained for foreign exhibitors, and that if any English company desired to take this up on the terms which have already been published, they could do so. The main bulk of the electric lighting has been arranged for on a commercial basis with American firms. They have not yet got all the power required for running dynamos, and would be glad if English exhibitors could send one or two 500 horse-power engines for the purpose. These engines would be placed among the lower plant, and the space allotted for the purpose adjacent to the Machinery Hall.

Such engines would have to be delivered free on the cars at Jackson-park. Foundations would be provided and the engines erected by the Executive. The cost of running would also be provided, including wages of engineer, who might, if preferred, be appointed by the exhibitors, but would be under the orders of the Executive. Engines on the same bed plate as dynamo would be quite acceptable. At the close of the Exhibition the engines would be dismantled and placed on the cars.

Special arrangements are to be made for the lighting of the Electricity Building. In this each foreign section can, if it chooses, light up its own space.

It is proposed to allow exhibitors to furnish all the lighting plant as exhibits. Steam would be provided free, but no payment would be made. Exhibitors who require current or light, and who do not provide generators, would be charged a low rate. Mr. Hornsby, the Chief of the Electricity Department, could not say what the rate would be, but it would be about cost price. The motors and generators would be placed among the power plant above referred to. Exhibitors would be expected to lay their own cables in the conduits, do their own wiring, provide lamps, &c. The generators, cables, &c., might be supplied by different exhibitors.

Exhibitors generating current would be allowed to use as much light as they pleased for themselves. In addition to the light thus supplied, the building will be lighted by arc lamps. For this light there is to be no charge.

Motive Power.

Mr. Robinson, the Superintendent of Machinery, would be glad if an English exhibitor would supply an engine of about 300 or 400 horse-power, to drive one of the lines of shafting in the British and German Court. The Germans propose to erect an engine, and this would drive the second line common to both Courts. The conditions on which this engine would be accepted would be the same as those for engines for running dynamos.

Music.

I had several interviews with Mr. William L. Tomlins, the Choral Director, and with Mr. Wilson, the Secretary of this Department.

The Department is inviting the principal composers in foreign countries to visit Chicago for the purpose of conducting each of them a work of his own. In this country they have invited Dr. Mackenzie, and, but for his severe illness, would have invited Sir Arthur Sullivan.

Before going to Chicago, I had had some communication with Dr. Mackenzie, who is likely to accept the invitation. It is proposed that a formal invitation should be addressed to him through the Royal Commission. The Committee have in contemplation the engagement of military bands, but no money has yet been voted for the purpose, and the arrangements are as yet incomplete. They have had some communication direct with Lieutenant Dan Godfrey, and, through myself, with Mr. Edward Holland, of the Scots Guard Band. I gave them all the information in my power about the English military bands, and promised that the Royal Commission would do anything in their power to further their views. They are also anxious to obtain the services of a good British choir. It is not proposed to pay this choir, but it is suggested they might cover their expenses by giving concerts in Chicago and elewhere.

Some German and Scandinavian choirs are coming over, arrangements having already been made by societies of those countries in America to bring them over and keep them while in America.

Juries.

There is no fresh information on this head. The proposed regulation for Juries are contained in the Report of the Committee of Awards to the National Commission issued some time ago. The acceptance of this report has been delayed, pending a settlement as to

he appropriation by Congress. As soon as this question is settled, the Committee will issue their final regulations. They propose a fee of $1,000 for each foreign Juror. The number of the Jurors have not yet been decided. It is probable that exhibitors will not be appointed Jurors in their own class, but that they will not be prevented from acting on other classes.

Empty Cases.

The regulations for the storage of empty cases have undergone modification, or, rather, are in process of modification; for the latest statement on the subject, which will appear in the forthcoming pamphlet on Transportation—a proof of which was shown me by Mr. Jaycox, the Traffic Manager—is merely to the effect that suitable arrangements will be made for the care of exhibitors' empty cases.

Catalogue.

The arrangements for the Catalogues to be published by the Executive, and the sectional catalogues to be issued by Foreign Commissions, are not finally decided upon. In the official Catalogue, there will be no advertisements. It is proposed to allow every exhibitor three lines free of charge in the body of the work; every additional line, up to seven lines, will be charged for at a price to be hereafter decided. These charges will be made alike to United States and foreign exhibitors. It is not settled what arrangements will be made for collecting the amounts charged.

With regard to the Catalogues of the Foreign Sections, no regulations have yet been laid down.

Women's Work.

I am sorry that I was absolutely unable to obtain any fresh information with regard to the arrangements for the Women's Section. The general character of these arrangements does not appear to have been decided upon; the actual amount of space to be allotted to the different departments has not yet been allotted; nor has the amount of space available to foreign countries been decided. It is the wish of the Committee that they should receive application for space in the Foreign Sections. Since my return, I learn that a formal application for space has been made by the Secretary of the Ladies' Committee.

Fisheries.

I had a long conversation with Mr. Collins, Chief of the Fisheries Department, who is very anxious that Great Britain should be properly represented in his department. At present we have no exhibitors, except a few makers of fishing tackle. He had been in correspondence with some boat builders and others in England, a list of whom he furnished me with, and he thought it might be possible to secure models of fishing vessels and other fishing gear which had been prepared for and exhibited at the South Kensington Fisheries Exhibition. Besides models of trawlers, &c., he would be glad to have a few examples of actual gear, trawls, nets, seines, traps, &c., also whaling gear, and the products of the whale, seal, and walrus fisheries. He expected to have a good collection of specimens from the Cape, and was anxious to know what other British colonies would contribute. I undertook to apply to the India-office to know whether the collection of Indian fishes formed by the late Dr. Day could be lent, or any fresh collection formed.

Forestry.

A space of 1,700 square feet is being reserved in the Forestry Building for India, in the hope that a specimen collection of Indian forestry products may be sent. Since my return I learn that a small collection may be expected.

Charitable Exhibits.

Mr. Rosenau, the Superintendent of the Bureau of Charities, had been in communication with Mr. Loch, of the Charity Organisation Society, about exhibits of charitable and philanthropic societies. Mr. Loch has had some communication with myself. Mr. Rosenau showed me a draft of an explanatory circular, which he said would be ready in about a fortnight, stating what this department desired. Reports, literature, charts, plans, statistics, &c., are amongst the things they seek. Full details will be given in the circular. I said I would suggest to the Royal Commission the appointment of a small committee, of whom Mr. Loch might be one.

Leather Exhibit.

I had one or two meetings with Mr. Macfarlane, the Chairman of the Leather Trades' Committee of the Exhibition, and also with Mr. Oakley, a member of that Committee. The Committee have raised a sum of money by contributions from representatives of the eather trade, with which they propose to erect

a separate building on a site to the north of the Dairy Building, and facing the lake. In this they propose to make as complete an exhibition as possible of leather, and applications of leather, both from the United States and from foreign countries. They are anxious for British exhibits; and I undertook, on the part of the Commission, to try and organise a small collective exhibit of British leather. Mr. Macfarlane promised to send me full details as soon as they were printed.

Live Stock.

Mr. Buchanan, the Chief of the Agricultural Department, gave me a little information about the arrangements for live stock. He said he could easily make arrangements for keeping stock of one sort while another was being exhibited, so that an exhibitor showing both cattle and sheep might have his cattle looked after while his sheep were being exhibited, and *vice versâ*.

Mr. Buchanan told me that the Agricultural Department at Washington had lately prohibited the importation of sheep from certain parts of Great Britain, on account of foot and mouth disease. He had very little information about it, but mentioned the matter in case we thought it desirable to protest.

He promised he would send on by next mail a complete memorandum of the alterations in the arrangements for exhibiting live stock. In the meantime he gave me the following dates:—

Horses and Cattle show together......	Aug. 21 to Sept. 21.
Sheep and Swine show together	Sept. 25 to Oct. 14.
Fat Stock	Oct. 16 to Oct. 28.
Poultry	Oct. 16 to Oct. 28.
Dogs	June 12 to June 18.

Transportation.

A new circular is in preparation, giving certain modifications in the rates for freight by rail to Chicago, and further information as to the methods of conveying goods to the Exhibition. I was shown a proof of this by Mr. Jaycox, the Traffic Manager, and hope soon to receive copies of the completed pamphlet.

Dedicatory Ceremony.

I took the opportunity of ascertaining the views of Mr. Baker on the subject of the Dedication Ceremonies. He stated very distinctly that he would much rather have people over there during the Exhibition than at the Dedication, if they were only able to visit Chicago once, though of course he would be glad for some representatives of the Commission to go out in October. There will of course be nothing to see at that time, as the buildings, although no doubt in a very forward state of completion, will not be entirely completed. There will be three days' festivities, and of course the ceremonies will be made of as imposing character as possible.

I discussed the question with other officials, and I gathered that it was the general opinion that members of the Commission who had it in view to pay a visit to Chicago would do well to make that visit during the continuance of the Exhibition, and not on the occasion of the Dedicatory Ceremonies, though they were gratified to learn that there would probably be a few members of the Commission present besides her Majesty's Minister at Washington.

APPENDIX I.

Pricing of Exhibits.—Letter of Director-General Davis.

"Chicago, Ill.,
"June 29th.

"*To the Honorable the Secretary of State, Washington, D.C.*

"Sir,—The publication in England of the letter which I had the honour to address the department under date of March 11th, 1892, in reply to the inquiries of Consul Augier, of Feb. 15th, 1892, in behalf of certain woollen manufactures of Rheims, has led to the inquiry from British manufacturers whether my letter was intended to revoke the permission previously given to foreign manufacturers to placard their exhibits with the prices at which they will be sold in bond.

"The paragraph in my letter of March 11, 1892, which refuses permission to the manufacturers of Rheims to placard their prices as requested in the letter of Consul Augier was a mistake, and I desire, therefore, to have that letter revoked by authority of the department, and the following statement sent out to Consular officers as the correct ruling in the case:—

"'Foreign exhibitors in the World's Columbian Exposition will be permitted to state upon placards attached to their exhibits the price at which said products will be sold at the place of manufacture, and also the prices in bond and out of bond, or exclusive and inclusive of the Customs duties in Chicago.'

"Asking that the same publicity be given by the

department to this correction as was given to my letter of March 11, I have the honour to be, very respectfully yours,

"GEORGE R. DAVIS,
"Director-General."

APPENDIX II.

REPORT OF THE HON. J. J. GRINLINTON, COMMISSIONER FOR CEYLON.

"Cannon-street Hotel, City, London,
"22nd July, 1892.

"*To Sir Henry Wood, Secretary to the Royal Commission, World's Columbian Exposition.*

"SIR,—1. In compliance with your request, I have pleasure in stating generally the steps taken by me at Chicago to obtain sites at the Great Exposition for the Ceylon Court and Tea Kiosks.

"2. At an interview which I had the honour of having with you, prior to my departure for America on the 4th May last, you were so good as to express approval of the steps taken by the Ceylon Government and the Planters' Association to send a Commissioner to Chicago on a preliminary visit, to see for himself what arrangements could best be made, and what sites could be obtained at the Exposition grounds for a Court and Tea Kiosks. You also mentioned that you thought, in the interests of the colony, it would be well if I acted independently, and on my own responsibility.

"3. Acting on your advice, which concurred with my own judgment, I proceeded to America, and immediately on my arrival at Chicago, on the 18th May, I waited on the Director-General of the Exposition (the Honourable Colonel Davis), also on the Honourable Walker Fearn (Chief of the Department of Foreign Affairs), and on the Directors and heads of departments, and explained the object of my visit, the nature of the exhibits which might be expected from Ceylon, and the paramount object which the Government and planters of Ceylon had in view in taking part in the great Exposition, namely, the desire to place Ceylon teas (which were so very favourably known in other countries) in the American market.

"4. I was met by all the authorities of the Exposition in a most friendly spirit, and succeeded in obtaining their co-operation, with authority to construct a principal Court, and Tea Kiosk (made of the woods grown in Ceylon), on a favoured plot of ground facing Lake Michigan, close to the British Head Quarters Building, and between the sites granted to France and Austria. I also obtained permission to occupy favoured sites in which Ceylon will have miniature Courts in the Agricultural Building, the Manufactures Building, and in the Woman's Building. The extent of each allotment has already been communicated to you. In all four Courts there will be suitable exhibits, and tea will be distributed gratuitously or by sale in packages, and also infused and served in the cup to such visitors as may desire it, under conditions which have been satisfactorily arranged with the authorities.

"5. Having obtained the objects sought in visiting Chicago, I made the necessary arrangements to go on with the foundation of the Ceylon Main Court, and other matters in connection with the Exhibition, including the selection and lease of suitable accommodation for the staff which will be sent from Ceylon early in 1893.

"I left Chicago on the 9th inst., and arrived at Liverpool in the s.s. *City of New York* on the 20th inst., and hope to reach Ceylon on the 30th August—returning again to Chicago with staff and exhibits in February, 1893.

"6. I cannot conclude this report without recording the obligations which Ceylon is under to the Director-General of the Exposition, Colonel Davis; to Mrs. Potter-Palmer, the accomplished President of the Board of Lady Managers; to the President, Mr. Baker; and the Vice-President, Mr. Higinbotham; to the Honourable Walker Fearn, the Chief of the Foreign Department; to Mr. Burnham, Chief of Construction; to Mr. Buchanan, Chief of the Agricultural Department; and to Mr. Allison, Chief of the Manufactures Department; also to the heads of the various other departments, who were most obliging in rendering their aid in every way they could.

"7. To yourself allow me to offer my best thanks for the information and assistance afforded to the colony I represent at the Exposition, and for the courtesy and consideration extended to me personally.

"The thorough and hearty co-operation of yourself and Colonel Grover, R.E., were such as to be of great help, not alone to Ceylon, but to every country which has the honour of acknowledging British rule and the influence of the Royal Commission.

"I have the honour to be, Sir,
"Your most obedient Servant,

"J. J. GRINLINTON,
"Special Commissioner for Ceylon to the
"World's Columbian Exposition."

Sites Granted to Ceylon.

	Square feet.
For Main Court	18,706
In the Agricultural Building	1,684
,, Manufactures Building	625
,, Women's Buildings (approximately)	625

Miscellaneous.

THE TIMBER TRADE OF BOSNIA AND THE HERZEGOVINA.

The superficial area of Bosnia and the Herzegovina is 51,155 square kilomètres (12,641,133 acres), of which more than half is reckoned as forest. A great part, however, of this so-called forest is mere brushwood, while other parts have been so devastated by neglect and reckless cutting as to be almost valueless at present as regards their timber. Her Majesty's Consul-General at Serajevo says that in the more mountainous parts of Bosnia and Herzegovina, far removed from the waterways, there are still extensive forests of very fine timber, in some parts even untouched yet by the axe. In the north, oak, fir, and beech predominates; in the south and west, beech and various coniferæ. It was only about the year 1830 that the timber trade in Bosnia commenced, and it was confined to the production of oak staves, as requiring neither costly establishments nor carriage roads. These Bosnian staves soon acquired a certain reputation on foreign markets, and were known in France as *Merrains de Bosnie*. In England all staves coming from Austrian ports were known as Bosnian staves. The oak found in the hilly part of Bosnia is the *Quercus robur*. Only, as rare exceptions, in certain marshy places, are found specimens of *Quercus pedunculata*, which is of quicker and larger growth than *Quercus robur*. The *Quercus robur* of Bosnia is of particularly slow growth. A tree 250 years old does not measure more than 17¾ inches in diameter; and trees rarely attain a diameter of 25 inches, and those that do show already signs of decay. The wood is softer, and less durable than the oakwood of Slavonia; but, on the other hand, it is more elastic, and easier to work. In Slavonia, it is not uncommon to find trees up to 50 inches; but, on the right bank of the Save, none such are—now, at least—to be found. The Bosnian staves, consequently, run somewhat smaller than the Slavonian staves. The latter average about 4·9 inches in breadth, and the former only 4·7 inches. A forest law existed in Bosnia under the Turkish Government, but it was never put in force, nor were there any forest *employés*. When the Austrians occupied the country in 1878, measures were immediately taken for the preservation of the forests from further devastation. By the new Austrian law all the forests in Bosnia and the Herzegovina were proclaimed to be State property, unless the ownership of private persons or of Vakuf (Mussulman Church) could be clearly authenticated. A Special Commission was appointed to carry out this work, which is yet far from completed. The forests are classed under the four following heads: — State property, Vakuf (Mussulman Church property), private property with unrestricted rights, and private property charged with certain communal rights. The peasants are allowed, as before the Austrian occupation, to cut wood and make charcoal for their use in the State forests in the vicinity of their abodes without payment, and have also the right of pasturage therein for their cattle. On all wood cut and charcoal made for sale they have to pay a tax. For some years after the Austrian occupation the timber to be cut was sold by public auction, previous notice of the intended sales being given in the newspapers, but this system has been abandoned of late in favour of private sales. Sales up to the value of 50 florins can be concluded by the district authorities (*Besirksämter*), and up to 600 florins by the Departmental authorities (*Kreisämter*), but above that amount only by the Central Administration at Serajevo. The cost of the staves to the cutters of course depends very much upon the position of the forest where they are cut, and the distance they have to be carried either to the railway or to a navigable river. For instance, a thousand staves cut near the Save would probably not cost more than 50 florins (£2) delivered at the frontier, whereas the same number from the interior of Bosnia would cost as much as 250 florins (£10). It is reckoned that in Bosnia three quarters of the price of a stave goes in freight, and in Slavonia less than half. A good workman in Slavonia cuts about 10,000 staves in a season, and is paid 20 florins to 22 florins per 1,000. In Bosnia, owing to the mountainous nature of the country, the severity of the weather, and the rugged growth of the trees, a workman cannot cut more than 6,000 to 7,000, and is paid 36 florins to 37 florins per 1,000. Cutting only takes place during the winter months, and ceases at the end of April. The staves are mostly sold either at the nearest station of the Bosna Bahn (Brod-Serajevo line), or at Sissek, which is the principal market for this article, whence they are sent by rail to Fiume or Trieste for shipment. There has been an enormous increase during the last five years in the number of staves exported from Bosnia. For example, in 1886, the number exported was 2,500,000; in 1888, 8,000,000; in 1889, 14,000,000: and in 1890, 26,000,000. Consul-General Freeman believes that these figures are rather below than above the mark, and has heard that the 1890 export amounted to as much as 30,000,000 staves. Taking the average price per thousand delivered at the frontier at £9, the value of the trade has risen from £22,500 in 1886 to £234,000 in 1890. About 90 per cent. of the staves produced are what are known in the trade as French staves, and the remaining 10 per cent. as German staves, these latter being larger, thicker, and more coarsely cut for the manufacture of large barrels. France takes nearly three-quarters of the number exported. The next best customer is Italy, and then Algeria, England, Portugal, and Spain, in the order given. Fiume is rapidly supplanting Trieste as a port of shipment for staves. The trade in Bosnian staves is said to be

passing through a very critical period. The production is ever increasing, but not the demand, and the capital engaged is said to bear at present but a low interest. There is also the fear that the oak forests of Thessaly and Asia Minor, which are as yet untouched, may prove dangerous rivals to those of Bosnia and Slavonia.

THE MINERAL PRODUCTS OF VENEZUELA.

A recent bulletin of the Bureau of the American Republics states that gold has been found in all the States and territories of Venezuela; but the deposits of greatest extent and value are those discovered in the Yuruary region, where the El Callao mine is situated. There are also out-croppings in all the mountainous lands between the Yaracuy river and the cities of San Filipe, Nirgua, and Barcelona. Near Carupano are some valuable mines, that have yielded seven ounces of gold per ton, besides others in the same locality that bare rich deposits of silver, copper, and lead. Valuable mines of copper at Aroa, in the hills of San Filipe, 70 miles west of Puerto Cabello, have long been worked, and the ore, which is a red copper of excellent quality, and preferred to the Swedish or Chilean ores, is exported to Europe. There are also undeveloped mines of this metal in Coro, Carabobo, Barquismeto, and Merida. There are many indications of red hematite and magnetic iron ores in the littoral Cordilleras, in the mountains round Coro, Barinas, Barcelona, and Cumana, and many parts of the Parima mountains; but the most valuable deposit is near the Imataca river, a confluent of the lower Orinoco, where an inexhaustible quantity of magnetic ore, assaying 80 per cent. of pure metal, lies exposed to view, and accessible to deep water. A lead mine, undeveloped, lying near Tocuyo, has yielded some valuable specimens. Tin ores are also found near Barquisimeto. Asphaltum exists in great abundance near the Pedernales river, an estuary of the Orinoco, opening into the Gulf of Paria, where petroleum wells have been sunk with good results, and a company has been organised in Caracas to work the property. The machinery is on the spot and in process of erection. Inexhaustible mines of mineral pitch also exist near Maracaibo, Merida, and Coro. Petroleum wells are abundant in Cumana and Trujillo. On the island of Pedernales, which is formed by the two delta streams, the Cucirina and the Pedernales, its northern shore being that of the Gulf of Paria, is found a vast supply of asphaltum. The land is low, intersected by small streams, and containing many ponds of salt and brackish water. In such ponds on the northern shore is found the asphaltum known as Pedernales asphalt. This differs in the main from that found at La Brea in Trinidad, in being generally more liquid, purer and freer from earthy matter, and in containing a greater per-centage of oils. Like the deposit at Trinidad, this is found in a series of springs in conjunction with water, and, as at Trinidad, it forms a thick flooring of pitch in places, and to an appreciable depth. The Pedernales asphalt is remarkably pure, and when refined, presents a hard, lustrous, vitreous fracture, and in appearance is identical with the Egyptian refined, known in trade as "Epuré." As found it is a thick, black, viscous mass, without odour and strongly adherent. The process of refining consists in merely boiling it, thus depriving it of a large proportion of the higher volatiles and all contained moisture. Refining may be carried on to any degree, even to the extent of complete reorganisation. The deposits at Pedernales may be said to be the same, geographically considered, as that of La Brea, notwithstanding that the Trinidad contains a quantity of earthy matter, well nigh inseparable, although mechanically mixed. These earths are mainly very finely divided clays, held in suspension by the viscous asphaltum. The presence of these impurities adds largely to the weight, and, while proving little detriment to the many uses of the material, debars it from many other purposes. The Pedernales deposit can be used for any purposes known in the arts, and is as desirable for varnishes and chemical compounds as it is useful in increasing the elasticity of the asphalt, which contain too small a per-centage of volatiles. The Pedernales asphalt can be refined to order, thus exactly fulfilling desired conditions imposed by users. Extensive coal deposits are found about 12 miles from Barcelona, and the area, only partially explored, discloses about 100 overtoppings of coal strata of regular formations, varying from four inches to seven feet in thickness. These strata are situated between layers of sandstone and schist, in the general direction of east to west, with an inclination of 45° to the south. This is also the general direction of the valleys where these deposits lie, through which run streams to the Neviri river. Large quantities of coal crop out above the level of the streams, and can be mined from horizontal tunnels and loaded upon cars without expensive pumping and lifting machinery. The quality of the product is such as is termed steam coal, and is easily ignited, producing much combustible gas, with a small proportion of argillaceous cinder, and a very small quantity of sulphur. In mining and transportation, it loses about 25 per cent., most of which can be recovered and worked into patent fuel. A rich salt mine, upon the peninsula of Araya, discovered in 1499, is still worked, from which the Government of Venezuela has derived a revenue, since 1873, of nearly $3,000,000. It consists of an inexhaustible deposit of almost pure salt, which is mined at very small labour and cost. In Lagunillas, near Merida, is a lake, the bottom of which is covered with *uras*, or sesqui carbonate of soda. Unworked mines of sulphur exist in Cumana, Barcelona, and Coro. Mines of jet and porcelain earth are found near Cumana and Caracas. Granite is abundant in the Silla Mountain, near

Caracas; and slate, marble, granite, gypsum, and lime exist in great quantities in the Coast Range and Parima Mountains. Thermal and mineral waters are found in many parts of the country. The hot springs of Las Trincheras, on the railway between Puerto Cabello and Valencia, are specially noted, their waters maintaining a temperature of 206° Fahrenheit. With the exception of the Urjino Springs in Japan, having a temperature of 212°, these are reputed to be the hottest springs in the world. Some remarkable springs are those of Coro, in La Quiva, near the road to Pedregal.

COAL DEPOSITS IN VICTORIA.

The "Victorian Year Book" for 1890 91, referring to the mining operations for coal recently carried on in the colony of Victoria, states that many attempts have been made to mine for coal, but the seams hitherto worked have been too thin to yield a profit. The reported discovery of thicker seams, however, and of large deposits of brown coal, chiefly in South Gippsland, led to the appointment, in July, 1889, of a Royal Commission, which was instructed to "inquire into and report as to the best means of developing the coal-mining industry of Victoria. This Commission has brought up a progress report, in which several seams of true coal, situated in different localities, are referred to, varying in thickness from 2 feet to 4 feet 6 inches; and in the annual report of the Secretary of Mines for 1890, it is stated that, by means of five diamond drills which were employed during the year, a seam of 3 feet 2 inches was discovered at Boolarra, and six seams at Korumbarra, varying from 2 feet 6 inches to 4 feet 11 inches in thickness of good coal. Early in 1891 the continuance of the Yambunna seam, of nearly 5 feet in thickness, and the discovery of a seam, said to be over that thickness, at Korumbarra, were reported, and coal mining at the two places named was being actively carried on. The deposits of brown coal, or lignite, in Victoria, are practically unlimited, and are thought to represent the largest supply of fossil fuel known in the world. The Coal Commissioners, in their first progress report, mentioned one mine, in which the thickness of the deposits ranged from 60 to 200 feet. They say that the brown coal differs materially from the black, both in appearance and character. It belongs to the tertiary formation, and represents only a partial degree of mineralisation. It is comparatively light, burns freely when dry, gives off a strong heat without smoke, and leaves a very small per-centage of ash. Its principal drawback arises from the quantity of moisture it contains, and the fact that the gas extracted from it is of low luminosity. A second progress report gives the result of a series of practical experiments with a view of ascertaining the value of brown coal for manufacturing, domestic, and other economic purposes. In regard to its illuminating power as compared with good coal gas, a ton of which should yield from 10,000 to 11,000 cubic feet of gas, of from 15 to 17 candle-power, and a residue of 12 cwts. of good marketable coke, it was found that, although from 6,447 to 15,083 cubic feet of gas was obtained per ton from the brown coal, the highest degree of luminosity was only 9·3 candle-power; and in some cases it was *nil.* For steaming purposes it required from 2·16 to 2·42 tons to do as much work as one ton of small Newcastle coal, whilst it required more stoking, and its comparative value for heating purposes was estimated at 8s. 4d. per ton as compared with 15s. 7d. for Newcastle slack. These experiments were made on the crude coal as it was taken from the mine, and it sometimes contained from 36 to 56 per cent. of water, the average being about 40 per cent. In the form of briquettes, however, there was evidence leading to the belief that it would be well adapted for domestic use; and with a view of placing the brown coal industry on a sound and permanent footing, the Commissioners recommended that a qualified person should be despatched to Europe for the purpose of acquainting himself with, and reporting upon, the methods adopted in Germany, and other countries in Europe, for raising and sending the coal to market, manufacturing the raw material into briquettes, and the application of the fuel to the industrial arts, to locomotive, domestic, and economic purposes. In accordance with this recommendation, Mr. Y. Cosmo Newberg, C.M.G., was despatched to Europe by the Government with instructions to inquire into and report upon the subject. At the present time the coal-producing colonies of Australasia are practically New South Wales, New Zealand, and Queensland, while small quantities have been found in Tasmania and Victoria. In these over 4,000,000 tons of coal were raised in 1890, but three-fourths of this quantity come from New South Wales.

PRODUCTION OF MACEDONIAN TOBACCO.

M. de Lacretelle, French Consul at Salonica, in a report to his Government, says that Macedonian tobaccos are universally known and appreciated; from time immemorial their excellent qualities have enjoyed a high reputation in foreign countries. It would be difficult to specify the period at which the cultivation of tobacco was first engaged in, but the industry dates from a very remote period, and for some years it has experienced a great development. Europe, Asia, Africa, and America purchase largely from the markets of Cavalla and Salonica, and to supply all the demands it has been necessary to increase the production to a very considerable extent. Since the establishment of the Ottoman tobacco monopoly, the cultivation of this article is subjected to stringent regulations, and although it is not limited, it is not free. The grower is obliged to make a declaration of the extent under cultivation; his plantations are inspected, and his product is

scrupulously verified. He is not bound to sell his product to the *Régie*, while the latter is obliged to purchase all that is offered to it. The trade in, and export of, tobacco in the leaf are authorised, but they are subject to control. The tobaccos are divided into two categories—the *bachi-baghli* and the *basma*. The former is distinguished by very pronounced stalks at the base of the leaves. When this tobacco is made up into bundles, the extremity of the bundle is formed by these stalks, which are tied with thread—hence the name *bachi-baghli*, or "heads tied." The *basma*, on the other hand, which have a very small stalk, are put up in bundles without being tied. The *basma* tobacco is considered to be very superior, and realises higher prices than *bachi-baghli*. In the production of the weed, Macedonia may be divided into two districts—the district of Cavalla, which is comprised between the Rivers Nestus and Strymon, and the region formed by the sandyak of Salonica, by the sandyak of Uskub, in the vilayet of Kossoos, and by the districts of Monastir and Serfidjé. In the latter region, which has a very extensive area, a large number of places are devoted to the cultivation of tobacco. The best known are those of Karaferia, Langhaza, Kilkich, Yenidjé, and Doïran in the vilayet of Salonica, of Perlipé and Florina in the sandyak of Monastir, of Elassona, Caïlar, and Nasselitza in the sandyak of Serfidjé. From the district of Salonica about 694 tons of tobacco were exported, and 350 tons retained for home consumption in 1890. The Cavalla district, from the point of view of the tobacco production, is a far more important one—the annual product varies between five and six thousand tons. The chief producing districts of the Cavalla region are—Sérès, Nevrokop, Djoumaia Pétrés, Drama, Sara-Chaban, and Cavalla. The district of Névrokop only produces *bachi-baghli* and the Sari-Chaban district *basma*, all the other districts yield both varieties. The finest descriptions of the former variety are those of Persotzan, Carlikova, and Coubalista, while those *basma* tobaccos, which are considered of the finest quality, are known by the names of Carchi-Yaka, Kirs, and Mahalés Kirs. The Persotzans, Mahalés Kirs, and Kirs are grown in the district of Drama. The Persotzan tobacco is moderately strong, of a clear colour, and a sweet taste; the Névrokop tobaccos are strong, the leaf is well developed, colour pronounced, and are frequently used for blending. Djoumaia Petris is an ordinary tobacco of rather bitter taste. The Mahalé Kir are very fine tobaccos with a small leaf, a good aroma and colour. Kir is a fine tobacco with a leaf more developed than the Mahalé Kir, and is considered of excellent quality for smoking. The Pravista is a light tobacco with a large leaf, it is largely exported to England and Austria. Cavalla does not only export the product of the districts comprised within the region of Cavalla, properly so called, but also part of the product of the districts of Xanthi, Yenidje, and Gumurgina, which extends from the Nestus as far as the Rhodope mountains, and comprises the plain situated between these mountains and the sea. Xanthi produces very excellent tobacco, particularly the description known as *yaka*, which enjoys a high reputation. For these tobaccos the principal consumers are Austria-Hungary, Egypt, Russia, and Germany. The methods of cultivation in Salonica, Uskub, and Serfidjé, and those practised in Cavalla and Xanthi are very different. In the former districts little care is devoted to it, whereas in the latter the greater attention is bestowed upon it. The ground is sown at the end of February, and in May, when the plant has attained a certain height, the first leaves are gathered—these are small and are found at the base of the stalk, and are known as *dipe*. These are in many cases considered as worthless. Towards the end of June the good leaves are gathered, these are called *cirindjiana*, and a few days later further leaves, known as *ikindjianas*, are harvested. At the beginning of August leaves higher up the stalk are plucked, the first being known as *outzoundjon-ana*, the second *outz-alk*, and finally the *outz* are arrived at, which are considered as the finest leaves of all. The harvest finishes in September. The yield is a particularly good one if the season is a rainy one after sowing, at the end of July and at the beginning of August. If the rains fall too heavily after the 15th August, the leaves develop quickly, but the quality suffers, and the colour of the tobacco is turned black. The leaves are picked as they mature, and considerable experience is necessary to know the exact period of maturity; if they are gathered too late the leaf becomes burnt up by the sun, and if too soon it remains green and turns out a bad quality. The leaves, when gathered, are strung together and hung up and exposed to the sun for about a week, until they are dry, when they are placed in warehouses, out of the rain. To commence the operation of separating the perfect leaves from the defective, it is necessary to wait for the first winds from the south, which give flexibility to the leaf. This operation lasts many months, as it is frequently interrupted by cold, which has the effect of rendering the tobacco dry and too friable. To avoid this danger, and to give more elasticity to the leaf, the growers frequently hang them in damp underground cellars. Merchants commence to make their purchases in January, and at the end of February all the tobaccos have been placed on the market. Exportation cannot take place before August, as tobacco is subject to fermentation in June and July, and it would be dangerous to manipulate the leaves. The culture of tobacco is very remunerative to the grower in Macedonia when a drought does not spoil a part of his harvest, and the prices now realised are far in excess of those ruling twenty or twenty-five years ago.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, AUGUST 12, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 10th inst. Present: The Attorney-General, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, R. Brudenell Carter, F.R.C.S., B. Francis Cobb, Prof. James Dewar, M.A., F.R.S., General Donnelly, C.B., Sir Henry Doulton, James Dredge, Walter H. Harris, C. M. Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, William Henry Preece, F.R.S., Sir Albert K. Rollit, M.P., Lord Thurlow, F.R.S., with Sir Henry Trueman Wood, M.A., Secretary.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 10th inst. Present: Sir Frederick Abel, K.C.B., F.R.S., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., R. Brudenell Carter, F.R.C.S., Francis Cobb, Sir Henry Doulton, James Dredge, John B. Martin, W. H. Preece, F.R.S., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

HORTICULTURAL DEPARTMENT.

The following letter from Mr. J. M. Samuels, Chief of the Horticultural Department, to Mr. McCormick, has been communicated to the Royal Commission:—

July 22nd, 1892.

Hon. R. S. McCormick, Official Representative, &c., &c., &c.

Dear Sir,—I am sorry to learn that information prevails among the British horticulturists that they will be "boycotted" by American dealers, should they attempt to make an exhibit at the Columbian Exposition. I have had similar information before from France and Germany, but from investigation I learn that this sentiment exists only among a few importers in New York.

I was informed by the German seedsmen that letters had been received by them from Americans—whose names they withheld for business reasons—to the effect that they would be "boycotted" if they made an exhibit at Chicago. I immediately wrote to a number of seedsmen throughout the country, and received replies from many of them couched in words of indignation that they should be accused of such actions.

At a meeting recently of the American Seed Trade Association, they passed very strong resolutions denouncing such action, and cordially invited seedsmen and horticulturists from all parts of the world to make as grand a display as possible.

Mr. Maurice L. de Vilmorin, of Paris, who at first hesitated to take part in the Exposition—for the reasons now first given in your letter—has recently been very active, and a few days ago submitted a proposition, by authority of the Horticultural Committee of France, to decorate all the grounds surrounding the Women's and Horticultural Buildings of the Exposition. This will require an expenditure of something like $100,000, to transport men and material.

Of all the countries in the world, the American horticulturists have been looking forward to the finest display being made by Great Britain, and I trust they will not be disappointed.

Very respectfully,

(Signed) J. M. Samuels,
Chief of the Horticultural Department, Chicago.

VISIT TO THE RUINS OF SUKKHOTHAI AND SAWANKHALÔK, SIAM.

By Ernest Satow, C.M.G.*

The result of my inquiries had been that Phichhai was the most convenient starting-

* Mr. Ernest Satow read a paper on "The Laos States, Upper Siam," before the Foreign and Colonial Section, on January 12 last, and the following account of his visit to the ruins of Sukkhothai and Sawankhalôk, in December, 1885, is extracted from his journal, which he kindly left for publication when he returned to Siam.

point for a visit to the ancient cities of Sukkhothai and Sawankhalôk, and at Phitsanulôk I had arranged with an officer whom I met there to procure eight elephants for the journey. On these were loaded a portion of our stores, and baggage sufficient for a week's use, the rest being sent on by the boat up to Utaradit on the same river. It took a couple of hours to pack the elephants, as the drivers are very careful not to overload their animals, and it is no easy matter to divide a large number of packages so that each beast gets a weight proportioned to his strength. Two elephants were specially reserved for Archer and myself, but I preferred starting on foot. The path lay for some distance through the jungle, which was still wet with dew, and then came out to a monastery (Wät Mô) standing amongst shady groves of fruit trees on the left bank of the river. But it was already getting too hot to walk, so we rejoined the main track to wait for the elephants, which soon made their appearance. As a rule, it may be said, that in Siam an elephant carrying what is considered a full load makes from two to two and a half miles an hour. It (he or she) appears to move each leg separately, and the rocking motion thus communicated to the howdah is extremely fatiguing. When I got off my elephant the first day, after about three hours' ride, my loins ached as if they had been well beaten, and even after becoming more accustomed to being shaken in this way, I never cared to ride on the elephant, except when fatigued by walking or by riding on horseback at a footpace. The howdah is a sort of covered tray supported by wooden frame-work in the shape of a V turned upside down, the covering being so constructed that the rider can see but little of the country through which he is passing. Underneath the tray there is sufficient space to hold a few light boxes of no small size. You spread a small mattress in the howdah, and wedge yourself in as best you can with pillows and cushions. Perhaps the least uncomfortable way of travelling on an elephant is to sit in front of the howdah with your feet on his neck, and your knees consequently somewhat pushed up towards your face. The mahout rides on the front part of the animal's neck with his legs, which he constantly agitates, dangling behind the huge ears, and it is the pressure on the latter that indicates to the elephant which way to go. A certain number of words are used to direct him to kneel down, lean his body on one side to avoid a projecting branch, or tear off with his trunk a bough that threatens to strike the howdah. When the elephant is disobedient the mahout strikes him on the head with a sharp spike fixed into a wooden handle, and not seldom makes the blood flow. When the elephant is displeased or frightened he either "trumpets" or omits a harsh snort like the sudden letting-off of steam. As he goes along he is constantly engaged in eating grass, leaves of trees, young twigs and branches, no matter whether thorny or not. Even bamboos covered with prickles are not despised. When he gets in at night he is fed with cocoanut leaves or sliced banana stems. After using his trunk all day in procuring his food, or smelling the ground in order to find where to place his next footsteps, he curls up its end and rests it on the earth. Sometimes you will see him with his trunk hanging over one of his tusks, in an attitude of deep contemplation. He is very fond of squirting dust over his back and under his belly, and of washing himself when he gets a chance. In passing a stream he never loses the opportunity of getting a drink of water, which he sucks up his nostrils as far as the root of his trunk, and then inserting the end into his mouth, he discharges the contents without even as much noise as well-bred people make in eating their soup. He has a tail like a bellpull, fringed at the end with hairs, and a small yellow eye indicative of cunning. The ear is like the door of a small cupboard, constantly flapping backwards and forwards. Looked at from behind he resembles a short-necked old gentleman with a scanty pigtail, whose gouty legs, encased in baggy shapeless trousers, move with the greatest possible deliberation.

From the spot where I mounted my elephant, which I had to do by climbing up a ruined tree, the mountains were visible far away to the east over a wide plain. Soon we had to leave the open track, and plunge into deep thickets, where the mahouts cut their way with knives through the overhanging branches and matted creepers. These knives, which are made in the country, resemble a midshipman's hanger, and may be used for a variety of purposes, including self-defence. However, you will oftener find a man employing his weapon to divide an areca-nut or to peel a section of sugar-cane. About noon we came to the river, and descended the steep bank with perfect ease and safety. I suppose an elephant scarcely ever stumbles in the course of a long life. In going down hill, where he

cannot walk, he folds his hind legs under him and slides slowly down, using his forelegs to regulate the rate of descent, while to ascend he adopts the opposite plan of climbing up on his front knees and pushing his huge bulk upwards with his hind legs. We crossed the river at Tha Maphueng, the grown-up elephants wading, while a baby elephant who came along with his mother swam with the tip of his trunk just above water. This little creature, who stood about three feet and a-half, was inclined to be gamesome, and offered to charge anyone who went near him, but his weight made it advisable not to try a fall. He seemed to be a pet with the other elephants, almost as much as with his own mother. I did not see any signs of the vindictive character so often ascribed to these animals, and certainly if they were capable of resentment, they would exhibit it towards their mahouts. But on the contrary, they stand in the greatest awe of their drivers, and their personal courage is in the inverse proportion of their size. They displayed the greatest alarm at the sight of a horse, and Archer's little black dog was a terror to them. That old story of the tailor who was deluged with dirty water by an elephant in return for a prick with a needle comes from Siam. It is told by one of the Frenchmen who visited Siam about 200 years ago, but I have never been able to find any confirmation of it, though I have inquired of several Siamese. Probably it was invented by one of the resident European merchants, and swallowed with the same avidity as the modern globe trotter gulps down the fables he picks up at dinner-parties on his way round the world. The best account of the elephant I have ever seen is to be found in Sir Emerson Tennent's "Ceylon." At first I was rather kept in awe by all I had heard about the animal, but afterwards, becoming more familiar, used to offer them bananas, which they took from my hand with the greatest gentleness, using, however, the mouth instead of the trunk, which they do not like to have touched. You never saw anything more weak-looking than an elephant's mouth, with its long pointed under lip, like that of an old man who has lost all his teeth. An hour after crossing the river we passed a few houses, and arrived at a *sala*, or large wooden shed, by the side of a pond, where I was glad to get down on to my feet again. Hearing that the next stage would be a long one, I resolved to remain here for the night. The *sala* was charmingly situated, in the middle of a forest, and surrounded by deep grassy glades, with groups of cocoanut and sugar-palms dotted about here and there. There were no mosquitoes, though the stagnant pond looked well contrived for breeding them in myriads.

At two o'clock in the afternoon of December 17th, 1885, we reached the town of Sukkothai, built on both banks of the Më-yom, which is here deep, though narrow.

The vice-governor of the province, who was at Phitsanulôk when I passed through on the 11th December, had been sent across country to make preparations for my reception, and I found he had got quarters ready for me in a large hall belonging to the principal temple of the town. It was what the Siamese call *Kanburien*, a sort of church, provided with three magnificently - carved and gilded pulpits. Round the upper part of the wall ran a painted frieze, representing scenes from the anterior lives of Buddha, but unfortunately there was no one in the place who could explain them. Such knowledge is extremely rare among the Siamese, perhaps rarer than that of the lives of the Catholic saints in England amongst Protestants. The roof was supported by rows of lofty circular pillars of rosewood, nearly two feet in diameter. It is, perhaps, necessary to observe that this timber takes its name not from the tree whence it is obtained, but from its red colour (*couleur rouge*). Along the side of the hall ran a raised platform, on which we deposited our baggage and had our bedding spread out. The rest of the afternoon was spent in arranging for a visit to the ruins of the ancient town of Sachanalai, in collecting information about the resources of the province, and in exploring the temple grounds. There was nothing particularly remarkable about the principal building, containing the image of Buddha (*wihan*), but in a shed close by, I found a collection of old bronze figures which had been brought from the ruins, and were now undergoing restoration with the aid of pieces of wood, paint, and the replacement of lost arms and legs by modern castings. Archer occupied himself in superintending a tracing of a native map of the province which the vice - governor had lent us, and in getting from that worthy various items of information which have appeared in the official report of our journey. Not being able to speak Siamese, I left all such matters entirely in his hands.

At six o'clock on the morning of December 18th, the thermometer stood at 69°, showing

that we must have descended considerably since we left Phichhai. At half-past seven we started on elephants from the opposite bank of the river for Sachanalai. The road lay at first along the muddy bank of a creek, which it then crossed, and we did not see it again till shortly before we got to the ruins. We passed three small hamlets, and traversed a good deal of rice-land, of which only about one-half had been sown this year, owing to the deficient rainfall, for, as you know, the cultivation of rice is almost entirely dependent on an abundant supply of water. Every now and hen our followers climbed a fence to rob a sugar-cane field of its luscious produce, which they peeled and devoured greedily, not however without giving the elephants a share. At a quarter-past ten we passed a tall *phra-chedi* of comparatively modern date, rising among some trees to our left, and entering a wood reached, in half-an-hour more, a *wat* standing on the edge of a lotus pond. Here on an island in the middle of the water is a half-ruined *phra-chedi* of stuccoed brick. Halting for a few moments at the *sala*, we proceeded on our elephants for 40 minutes more to the principal ruins, which the Vice-Governor had caused to be cleared in great part of the overgrowth of bushes that would otherwise have rendered them inaccessible.

The first object that attracted my attention was a massive square structure standing on a platform rising by steps from the general level of the soil, and on examining it closer I found the platform to be constructed entirely of blocks of stone, covered with a coating of very hard chunam. This is a very important fact. All of the buildings in Bangkok are of brick, and that material seems to have been universally employed in modern times, so that the mere fact of stone having been used is by itself an indication of great antiquity. The Sachanalai stone is laterite, which, when dug out of the ground is so soft that it can easily be cut, but it becomes extremely hard after exposure to the air.*

In the centre of the eastern side was a narrow and lofty opening, the sides of which approached each other towards the top, forming a truncated acute angle, and across which were laid slabs of what looked like green slate. The outer dimensions were 53 feet 4 inches on every side, the height being apparently the same, and the base was nearly 80 feet square. At the top of the wall were remains of an elegantly mounted cornice. All signs of roof had disappeared, but I incline to the belief that it must have been pyramidal. There were traces of a porch having existed over the doorway.

From the measurements I took, the walls appear to be over 8 feet thick at the sides; and the inside of the building is, therefore, only about 37 feet across. At about three-quarters of their height from the floor, the walls begin to incline inwards, and, if continued upwards in the same curve, would terminate in a sharp, many-sided point. The concealed passage starts from one side of the entrance, and, winding upwards, seems to pass out on to the top of the wall behind the image. On the south side it opens into the interior by a doorway 5 feet high and 2 feet wide. Unluckily, we had no candles, and therefore could not explore the passage. These passages have since been examined by Pere Schmitt, who found them to be covered with sculpture incised on blocks of stone. The walls are of large red bricks, covered with stucco.

East of this building there had been a *wihan*, the outer walls composed of low, cylindrical, laterite pillars, covered with stucco, the space between having been filled up with brick, while two rows of similar columns mark off the aisles. Fragments of a coarse pottery, having a pale, stone-coloured glaze, and picked out with designs of light brown, were lying scattered about. They take the form of Buddhist angels, lions, and small pagodas, their precise employment being uncertain, but they were probably intended for decorative purposes. There are also numerous small Buddhist images, of a fine-grained green stone, resembling slate, the largest fragment being a head about eight inches high.

From this place I returned with Archer to the *sala* for lunch, and afterwards visited the ruins of a temple mentioned in history as the Wât Na Phra-that. It consists of a much larger group of buildings than the first one. The principal edifice is a *wihan* 136 feet in length, and about 40 feet wide. The roof and walls have long ago disappeared, but many of the four rows of laterite pillars which ran down each side of the building, giving it three aisles with a broad nave between, are still erect. These pillars diminish in height and size from the nave outward, the highest being about 25 feet, and are built up with thick circular slabs of stone, covered over with chunam. The

* Being of a deep red colour, it is a very effective material, and in Rangoon, where it abounds, it has been recently utilised for public buildings.

outer walls were of brick. At the eastern end we found a block of green stone half sunk in the ground bearing an imperfect inscription. Beyond this is a small shrine raised high above the level of the floor, the roof of which had been supported on four pillars. The image of Buddha which this shrine once protected from the weather is still in position, though much dilapidated.

At the other end of the building is a large *phra pang*, or group of nine pagodas, having a common base built partly of brick and partly of laterite. Much of this is in ruins, but considerable remains of chunam reliefs show that it was once a very fine work of art. One of these reliefs appears to represent the death of Buddha. Behind it are eight pillars belonging to the *bôt*, a building where the consecration of the priests takes place. On either side of this again rose a sort of cella with thick walls, containing an image of Buddha 40 feet high, nick-named Sao sip-ha pi, "the girl of fifteen years," the tradition being that they are the exclusive handiwork of a damsel of that age. Close by there is a stone called the Khóm dâm dîn, or "Cambodian who dived into the ground." It is connected with the legend of the freeing of Siam from the yoke of the Cambodians by the celebrated magic-working King Phra Ruang. He had fled hither from Cambodia, and was pursued by a Cambodian general, who dived through the earth in search of the fugitive, and came out at this spot in the centre of the temple. On his inquiring where Phra Ruang was to be found, the latter replied "Remain where you are till he comes," and the Cambodian thereupon was transformed into stone. It is said that the present stone is only the remains of a pillar, fragments of which have been carried off from time to time to be used as charms, so that very little of it is now left. According to the Siamese official chronology Phra Ruang reigned about 1250 years ago, so that the temple would be even older, but I fear their dates are not to be trusted.

More remains of buildings were to be seen in the jungle, but it was impossible to trace their outline, owing to the thickness of the brushwood that has been allowed to almost cover them from sight.

We took just three hours to get back to Sukkhothai, arriving there after sunset by the light of the full moon.

About half-past one on December 20 we reached the Ban Wang Mekôn, the seat of government of the province of Sawankhalôk. The court-house (*sala klang*), on the left bank about the middle of the town, had been fitted up for my accommodation by bringing away from the governor's house (he was absent) part of the bamboo and palm-leaf walls and partitions, and supplementing them with curtains. Moreover, there were tables and chairs lent by a rich Chinaman, the local spirit farmer. Mats and carpets had been laid down, the neighbouring ground had been cleared of weeds, and a kitchen and bath-room had been constructed close by. The elephants arrived by land at the same moment that we came in by water, but as the authorities had taken so much trouble to make things comfortable, I renounced my intention of going on that day. In the absence of the governor at the seat of war on the north-east frontier, I was received by the *palat*, or vice-governor, a one-eyed man, who seemed to be crammed with want of knowledge about the resources of his province. Sawankhalôk is famous for the ancient chinaware which was made at the old city in prehistoric times, and specimens are now and then available. I asked the vice-governor if he could help me to purchase some, and later on he brought a bowl of earthenware with a pale-green glaze, which he pressed me to accept as a present. I declined to deprive him of this valuable curiosity, but regretted afterwards the excess of delicacy that had led me to refuse the offer, when I learnt that he had appropriated it from the original owner without payment.

The river is now very shallow, but it is said that at high water boats can go much farther up, namely, to Mu'ang Long, on the frontier of Lakhon and Phrë, where there are rapids which prevent aay further progress. The bank is about thirty feet above the present level of the river. Along the left bank extend the houses of the principal officials, built of wood, each standing in a separate compound full of fruit trees. In this it differs markedly from Sukkhothai, where the houses are built side by side close to the river bank, without the sign of a tree. Here the houses are so surrounded as to be almost invisible from the river. To judge from the mere outward appearance you would fancy yourself in the country of the Laos instead of in Siam.

At a quarter to ten, on December 21st, we passed the village of Tai-chai, extending on both sides of the river. There were a considerable number of trading-boats laid up for the season, and in connection with almost every one there had been built a rough shanty on a raft of teak logs. A good

many Chinese were stopping here, and, of course, they had established the inevitable gaming house, distinguished by its orange paper placards covered with characters in black ink. About a quarter before 11, I caught sight of a lofty *phra-chedi* in a conspicuous position on the high river bank, and passing to the right of a considerable hill, covered as usual with trees to its very summit, we arrived by noon at a wood and bamboo building that had been erected some months since for the accommodation of a Siamese prince. It had been much overgrown with weeds, but these had been cleared away in anticipation of my arrival, and were lying in festering heaps in the hot sun. The bamboos of which the inner rooms were constructed had been gnawed by a disagreeable little insect, and the walls were absolutely covered with a thick deposit of yellow dust. The outer part of the building was a sort of open shed with a raised floor and a verandah running round three sides on a lower level. This was utilised as a dining-room and reception-hall for ourselves, while the mahouts and servants lay about on the verandah, taking a silent part in the conversation.

It was not long before we were visited by some priests from the ruined temple close by, and I took the opportunity of asking whether any specimens of the old pottery were procurable. To my great joy they produced two fragments, one of which would have been worth, according to their estimate, a couple of ticals (tical = 2s. 2d.) if it had been whole. I bought both pieces at that price, and the word was immediately passed round the hamlet to bring more. In the course of the afternoon child after child appeared, each with two or three examples that he had dug out of the ruined kiln, where they had been baked centuries ago. I purchased everything. Not one specimen was perfect, and this is the best proof of their genuineness. China and Japan are the only countries where green celadon is produced now, and it would not be worth any one's while to import from those countries the potters' failures, on the meagre chance of selling them at Sawankhalôk to any collector who might come that way. Their very condition confirms the story that they are found from time to time in the heaps of rubbish surrounding the remains of the kiln. I regret I did not visit the spot, which is said to lie some distance to the north in the jungle beyond the old city walls. Of all the pieces I obtained, only one resembled porcelain. It is a small dumpy jar-shaped bottle, with three figures of Buddhist angels under the white glaze. Another resembled our stoneware, and a few specimens were what is called crackle. But the finest were jars of green pottery, much constricted at the neck.

At old Sawankhalôk there are some thirty-five ruined temples, of which the foundations can still be traced, mostly overgrown with brushwood and hidden in the jungle. But close by the rest-house rises the lofty pagoda we saw as we approached the place in the morning, and another temple called Wât Na-Phra-that. This consists of a *wihan* 32 yards long by 10 in width. The nave was originally supported by ten octagonal pillars of laterite, covered with chunam, while the outer walls were built up of brick-shaped laterite blocks between pillars of the same material. These pillars are about three-quarters of a yard in diameter, and about 20 feet high. The side-walls are pierced with windows. At the west end is a large sitting figure of Buddha, built of stone blocks, plastered with chunam, and piled all about the pedestal are a number of smaller images in bronze, ivory, terra-cotta, and wood, in an advanced stage of rust and decay, and mostly wanting arms, legs, or head. I persuaded the priest who showed us round to sell three of these for a tical each. A Siamese official would probably have taken them away without payment. At the eastern end of this *wât* are the ruins of a lofty *phra-chedi*, built of the same stone as the *wihan*, but so disfigured that its original outlines are no longer visible. The *wihan*, however, is in decent repair, having been, until lately, inhabited by the priests. At the south-east corner, outside the porch, is a cellar with thick walls, containing an erect figure of Buddha, as at Sachanalai, and likewise nicknamed the maiden of fifteen. The whole area is surrounded by a solid wall of laterite blocks, on the top of which is a coping of the same stone.

Beyond this, and almost to the centre of an oblong enclosure rises the well-preserved *pra-chedi* already mentioned, forming part of the monastery Wât Phra-prang. The *phra-chedi* must at least be 80 feet high, perhaps 100. The inhabitants give it about 134 feet, but that is no doubt an exaggeration. At the outer entrance to the central cell, which is approached from either side by a steep flight of steps, are a pair of wooden doors, carved in high relief, representing two angles. The drapery is boldly rendered, and recalls to mind the finest specimens of Buddhist sculpture to be seen

in Japan, which are, as is well known, at least eight centuries old. In modern times all these countries have fallen far below their ancient artistic standard, which seems to have been affected by Greek influences derived from north-western India, or, more exactly speaking, the Punjab. At the end of a narrow passage a massive slab of wood closes the inner entrance to the cell, in which is a sitting figure of Buddha of no particular merit.

Immediately east of the *phra-chedi* is a *wihan*, of which most of the pillars and outer wall are still standing; they are octagonal, as in the other temple. At the west end, with its back to the *phra-chedi*, is a sitting figure of Buddha. We can see how these images came to occupy the important place they do in the Buddhist temples. The *phra-chedi* was supposed to contain relics of the cremated body of Gautama, and in front of it the devotees built a shed or hall to protect them from the weather while saying their prayers. Afterwards they placed a representation of Gautama, generally in the act of preaching, be fore the entrance to the shrine containing his relics, and thus, in course of time, the ignorant populace addressing their prayers to the image came to be idolaters, though their priests, as long as they continued to be educated in their religion, knew well enough that the image was a mere symbol and aid to devotion.

The enclosure is formed by a wall of massive circular stone columns placed close together and surmounted by a heavy coping. Round the inside there once ran a cloister supported on circular pillars, the capitals of which were richly decorated with designs in chunam, and the exterior wall of the *phra-chedi* was similarly surrounded by a cloister. At the east and west ends are gateways, each formed of three massive cylindrical pillars, now half buried in the ground. Indeed, it is worth noting that the level outside is much higher than that of the enclosure, which is no doubt to be ascribed to the gradual deposit of soil by the annual floods.

Outside the enclosure, and still further east, is a square building with a pyramidal roof. Here the people still come to present offerings to the Manes of the prehistoric King Phra Ruang, who reigned here as well as at Sukkhothai. I found it crowded with a mass of trash, such as clay elephants with half-burnt bits of joss-stick inserted in the hole where the head should have been, pieces of dirty rag, &c.

The examination of these buildings in a broiling sun was rather hard work, and we went back to the rest-house for a cup of tea before starting for the outer ruins, which were said to be some distance off. In fact, we found it took three-quarters of an hour to get there. The path lay along the western bank of the river for a long way, and then plunging into the jungle, we reached the ruins of Wât Chan Lom, passing what is said to be the site of the old palace. But of this nothing remained, and no wonder, since until within a few years all Siamese buildings, except temples, were constructed of wood. We found the main portion of the ruins to consist of a stone wall enclosing a ruined *phra-chedi*. This stood on a lofty basement, surrounded by seven life-sized stuccoed elephants on each face, except where there was a staircase giving access to the platform. At each corner stood a still larger elephant. Round the next stage were rows of sitting Buddhas in horseshoe niches, five on a side. The spire was quite plain. The enclosure wall is of cylindrical pillars set close together, with a coping.

One point worth noting is that the stone is never carved, all the sculptural ornaments being produced by the aid of very hard chunam (or cement), which probably would last for ever, but for the ruinous force of the plants, chiefly a species of *Ficus*, which thrust down their roots wherever they get a chance, and thus destroy an uncared-for building in an incredibly short space of time.

Portions of the old city wall are still to be discerned, and in fact they lie for some distance along the river bank. The stream makes a very sharp bend just beyond the Wât Phra-prang, and the angle thus formed was doubtless entirely occupied by the city, a line being drawn across the base of the angle so as to connect the bank at two points. About two miles above the bend, within a short distance of each other, are two sets of rapids, formed by masses of rock lying in the bed of the river. We descended to the upper rapids. Large blocks of laterite, half-buried in the bank, lay close to the path, and it is evident that the stone used in constructing the temples must have been quarried in this vicinity, although the priests and villagers said, in answer to questions, that they did not know where it was to be found. The fall of water at this rapid seemed to be about ten feet, and it makes a considerable roar as it rushes down the narrow channel between the rocks. Above it stretches a long placid reach, curving some-

what to the east, between high grassy banks crowned by high forest trees, while below the river flows away less peacefully to the south-east between two low islets.

Miscellaneous.

THE WORLD'S COLUMBIAN EXPOSITION FOR 1893.*

BY JAMES DREDGE,
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AND
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The great size of Jackson-park, which was assigned by the municipality of Chicago as a site for the World's Columbian Exposition of 1893, enabled Messrs. D. H. Burnham and J. W. Root, the engineers and architects of the Chicago Commission, to prepare a general plan of the exhibition buildings, upon the basis of at least 50 per cent. more covered space than was available at the Paris Exhibition of 1889, while at the same time an ample area was left, which the skill of the landscape gardeners, Messrs. Olmsted and Co., has converted into a noble park that forms a suitable setting for the great range of buildings composing the Exhibition.

Except for the fact that Jackson-park is six or seven miles from the centre of Chicago, it is an ideal site for a great exhibition; for as it skirts the southern shore of Lake Michigan the waters of that inland sea can be turned to full account, not only to supply the lagoons, canals, and basins, on which so much of the beauty of the park may depend, but it will afford a means of permitting a naval exhibition to be held which, in completeness, variety, and interest, will be without a parallel. Everyone by this time must be familiar with the form of the triangular piece of ground on which the Exhibition will be held: it skirts the south-western shore of Lake Michigan, and covers an area nearly twice as large as Hyde-park. There is thus sufficient space to allow of the construction of many miles of public walks, and also for the erection of a series of great buildings—to say nothing of very numerous pavilions — which will be devoted to different branches of art and industry, and which collectively will cover no less than 150 acres, or about twice as much as the covered area of the Paris Exhibition of 1889.

There are no fewer than eleven main buildings, devoted respectively to agriculture, machinery, manufactures, and liberal arts, electricity, mines, and mining, transportation, horticulture, women's industry, the fine arts, fisheries, and the exhibits of the United States Government. Besides these, there is also a great monumental building, reserved for the administration. This latter occupies a dominating position at the end of a vast court, around which are grouped five of the principal structures above referred to, and devoted respectively to agriculture, measuring 500 feet by 800 feet; machinery, 492 feet by 846 feet; manufactures and liberal arts, 787 feet by 1,687 feet; electricity, 345 feet by 700 feet; and mines and mining, 350 feet by 700 feet. The effective areas of these buildings are further increased by very extensive annexes, especially those devoted to agriculture, which include several great pavilions for live stock, forestry, dairy farming, and extensive ranges of sheds for the exhibition of cattle. The principal façades of these five buildings just mentioned form the north and south enclosures to the great central court, at the western end of which is the administration building, while the eastern end is extended into the lake by a pier of large dimensions. In the centre of the court is a basin, which will be enriched by monumental fountains, and which forms a connection between the extensive and ornamental waterways of Jackson-park and Lake Michigan. Each of the principal buildings, so far, at all events, as architectural effects are concerned, has been designed by a different American architect, all of them selected on account of their eminence in the profession. Certain leading conditions have been observed by them, so as to secure harmony in the general effects, both as regards proportions and classic character; in other respects each architect has had an entirely free hand in his designs. The buildings themselves, which are magnificent in dimensions and most elaborate in detail, will thus form exhibits illustrating the development to which the science of architecture has been brought in the United States. As the remaining principal buildings on Jackson-park are more or less independent of one another, greater freedom of design was permitted to the architects, but as in the case of the main group, they are also intended to serve as exhibits contributed by Chicago architects. The transportation building, 250 feet by 960 feet, is simple in its outline, and almost barbaric in the richness of its decoration; the horticultural building, almost as big as our own Crystal Palace, is, like it, a magnificent example of construction in iron and glass. The women's building, 196 feet by 386 feet, is the design of a lady architect, and is severely classic in its outline. The art galleries will undoubtedly be the most beautiful structures that have ever been seen at any exhibition; the leading characteristic of the fisheries building will be its picturesqueness, and the United States Government is erecting a structure remarkable for its elaborate architectural effect and the beauty of its decoration. There is no room to speak of the many pavilions that will be scattered over the ground; they will include contributions from every State of the Union, from every nation exhibiting, as well as those erected by the numerous exhibitors privileged

* Paper read at Edinburgh at the meeting of Section G of the British Association.

to erect buildings for themselves. The most varied and interesting of these will occupy a space of ground projecting from Jackson-park, and which will form, practically, a street of nations a mile long. The work of the Exhibition has now advanced so far that it is within measurable distance of completion, and it will scarcely be doing justice to the Chicago executive to say that in extent, beauty, and completeness, it will as far surpass the Paris Exhibition of 1889 as that exhibition eclipsed all its predecessors.

The administration building, of which the main feature is a dome 120 feet in diameter, rising to a height of 275 feet from the ground, is a beautiful example of boldness in design; in the other buildings, with one exception, there is nothing unusual in the dimensions or the treatment, from an engineer's point of view. The roofs are neither very great in span, nor original in design, the main object having wisely been to cover a vast area in the cheapest and most expeditious manner consistent with a realisation of the best effects for the special purpose for which each building was intended. Considerable interest, however, attaches itself to the foundations of all the main buildings. In constructing these, the system found most useful for the great permanent buildings of the city of Chicago has been adopted for these temporary structures; that is to say, a system of independent platform foundations, each unit of which distributes, independently of all the others, a safe proportion of the load which has to be supported by the thin bed. This is a peculiarity which the local conditions of the ground render advisable.

The exception above referred to, when speaking of the engineering features of the exhibition buildings, is found in the great hall devoted to manufactures and liberal arts: this will have the largest roof that has ever yet been constructed. The building covers an area of over 30 acres, and consists of a central gallery, 387 feet clear span, and no less than 210 feet in height: the length of this vast hall is 1,237 feet, and the great roof is hipped at each end. It is surrounded with a series of galleries, insignificant by contrast both as regards height and span. The trusses forming the great roof are of steel, and resemble, to some extent, especially as regards size, the somewhat smaller and considerably lower arches of the machinery hall of the Paris Exhibition, which, up to the present, has surpassed any other structure of the kind.

It will be remembered with what intesest engineers of every nation watched the erection of that great roof, which was undoubtedly a triumph of the contractor's skill. The erection of the liberal arts building is a work of much greater magnitude, but it is being carried out by simpler means, and with greater facility than the Paris machinery hall.

A travelling stage, wide enough to include two trusses and the whole width of the building, is employed. On this staging are two towers, framed in timber, higher than the roof. The erection of the trusses is carried on from the ground and from the staging to a height of about 100 feet, that is to say, to the level of the main platform of the stage. The upper halves of each pair of trusses are put together upon this platform, and when the lower portions are completed and connected with the longitudinal bracing, the inner members of the upper and lower sections are connected by means of pins, so as to form hinged joints. By means of powerful hoisting apparatus, worked from the floor of the stage, the upper halves are then hoisted to their final position, turning on the hinges. When fully raised, the central joint is made good, the outer members of the upper and lower halves are rigidly connected, the hinges are removed, and the permanent joints are completed by rivetting. In this way, the work is rapidly carried on, and it is expected that the building will be ready for the great inaugural celebration in October next.

*SECONDARY BATTERIES IN USE AT THE CENTRAL TELEGRAPH OFFICE, LONDON, FOR TELEGRAPHIC PURPOSES.**

By W. H. Preece, F.R.S.

In a paper entitled "The Use of Secondary Batteries in Telegraphy," communicated to the British Association at the meeting held at Montreal in 1884, an account of a series of experiments was given which had been carried on during the preceding twelve months to determine the suitability of secondary batteries for telegraphic purposes.

Since that time the use of secondary batteries has been extended, and for the past seven years they have been used to supply current to two large groups of circuits, one group consisting of 110 single needles, and the other of 100 Morse inkers and sounders.

To provide a ready means of replacing the battery in case of failure, the leads from the working and reserve cells, which are placed in the basement, are first led up to the test-board in the instrument room, and there joined to a switch; thence the leads are again led to a test-board in the battery room, where the two groups are split up into sub-groups of ten circuits each. The connections are made in this manner for two reasons: first, for facilitating a change of a faulty battery, and second, to prevent a general stoppage of the whole group in the event of a short circuit at any of the instruments, the resistance of the leads between the instruments and the subdividing connections in the basement being sufficient to prevent more than three ampères being taken from the battery by any one of the instruments, even when a short circuit is on. To prevent any damage to the instruments or risk of fire, fuses are placed in the battery leads at each instrument.

* Paper read before the meeting of Section G, at the British Association.

The circuits on the groups mentioned are all metropolitan, and are all, approximately, of the same resistance, no equalising resistances being therefore necessary. The current in each circuit ranges between seventeen and twenty milliampères.

The E.M.F. for the single needles is twenty volts, ten cells positive and ten cells negative, with earth in the centre. For Morse working the E.M F. is eighteen volts.

In addition to these two groups another set of twenty-two cells has been in use since 1889, supplying current for driving the motors of the Delany multiplex distributors. Each of these motors requires a current of about ·12 ampère, and there are ten of them at present driven from this source. Fuses are placed in the leads to each motor. There is no spare set for this work.

A considerable extension of the accumulator system has recently been made, advantage being taken of the transfer of all the Continental service to the General Post-office building in St. Martin's-le-Grand. This transfer was made on October 17th, 1891, and since that date the whole of the Continental circuits have been operated by currents from secondary cells.

There are fifty-nine of these Continental circuits, and as they are of various lengths, some requiring repeaters in England, whilst others go direct to the Continent, a somewhat different arrangement has been adopted. In addition to these varying conditions it was found impossible to use the same polarity in all countries, the German, Dutch, and Belgian lines taking positive, and the French negative.

It was also necessary to provide an arrangement which would cause the stoppage of the minimum number of lines should a main fuse be burned or a battery fail.

The fifty-nine lines are divided into four groups; but as the force required for these long lines is 100 volts, it is evident that the risks of allowing a dangerously heavy current passing out from the instrument to line should it make earth near the sending station, is increased. To provide against this, resistances of 100 volts are placed in the battery leads at each instrument, so that it is absolutely impossible that more than one ampère can flow even with earth on the line close up to the instrument. Independent three-ampère fuses are also fitted to each instrument to prevent any damage to lines or instruments should the safety resistance be short-circuited.

As it is sometimes necessary to put repeaters in on the English side of the cable on some lines which nominally work direct to the Continent, the resistance blocks on several of the instruments are wound to 1,000 ohms, and fitted with a switch which enables either 100 ohms or 1,000 ohms to be inserted in the battery circuit, and thus the current is kept constant. In addition to the independent three-ampère fuses, main fuses to break at ten ampères are placed on each group of circuits in the accumulator room.

All the coils are kept well charged, and the E.M.F. is not allowed to fall below 1·95 volt per cell. Where spare or reserve sets are provided the charging is carried on at any convenient time, and on those where no spare is in use the charging is done at night, when the minimum disturbance is caused by the slight increase of E.M.F. which is inseparable from simultaneous charging and working.

Accumulators are also used for working the Paris telephone circuits. Their E.M.F. is so constant that they are found to be eminently adapted for the purpose.

THE INDUSTRIES OF MOROCCO.

A meeting of the Geographical Society of Leipzic has recently been held in that city, when a report upon the condition of Morocco was presented by Dr. Jannasch. The following particulars are extracted from the report in question. The industries of Morocco, from the European point of view, are in a somewhat primitive condition. There are no large factories, the only work in the various industries that are engaged in being performed by workpeople at their own houses. The work, however, turned out by these artisans is very remarkable, and testifies to their great skill in the treatment of the raw material. The art of the workmen engaged in preparing brushes and brooms, reed mats, mats and tissues of alfa, as well as alfa and palm leaf cordage may be considered to have reached a high standard of development. These articles are frequently made in different colours, and, in addition, many others are manufactured with considerable taste, such, for example, as hats of palm leaf and baskets of the same material, into which strips of leather are interwoven. Spinning is done in the towns, as well as in the country districts, by the hand-spindle, which is in use everywhere, but is not always of the same size. The yarn obtained is frequently of great fineness. It is only exceptionally that mixed threads are made, those of wool predominating. Among other uses, they employ these latter by hand-looms in making tissues of considerable beauty, and which resemble muslins. These are about five metres long and two metres wide, and are known as *hayaks*. With coarser and stronger yarns they make what are known as *djlacas*, a species of cloak with a hood. At Rabah excellent carpets are woven in natural colours, while in the majority of the other places of production aniline colours are used. The dyes employed in carpet manufacture are most frequently very glaring, but their effect notwithstanding is extremely harmonious. The greater part of the designs are excessively primitive. The leather industry is largely engaged in, and considerable quantities of harness and leather bags and pouches are turned out. For the latter articles various descriptions of leather of different colours are used, and the harness, as well as the bags

and pouches, are frequently ornamented with threads of gold and silver, and they are also richly embroidered. The Morocco slippers are well known, and have been for many years in Europe. Of these articles, Morocco exports about £40,000 worth to other countries in the North of Africa and to the east. The leather produced in Morocco is not equal in quality to the European article, and this is not because the tanning materials are defective, but in all probability because in the tanning itself certain substances are used which have the effect of diminishing the resisting power of the leather. Dr. Jannasch is of opinion that with the large number of hides which are at the disposal of the inhabitants each year, the tanning industry ought to attain a high degree of prosperity in Morocco. The earthenware industry is very extensively engaged in, and many articles of original design are produced. The red Fâs vases are very beautiful both in form and colour. They have frequently an antique classic shape, and are painted with cobalt and graphite, as well as with a particularly brilliant green colour. As regards the wood industry, those engaged in it almost exclusively use the Argan timber, which is as hard as iron and never becomes worm-eaten. The clothing trade is more frequently in the hands of the Jews—the greater part of the articles are made by women, who are very industrious.

BARCELONA EXHIBITION.

Further information respecting the International Exhibition of Reproductions from Artistic Industries of all ages till 1815, which was referred to in the number of the *Journal* for July 8, has been received. The Exhibition will be opened on the 24th September, and closed on the 26th December. All works sent for exhibition must be delivered at the offices of the Secretary of the Exhibition (Fine Arts Palace, Barcelona) before the 1st September, and must be withdrawn within ten days after the closure of the Exhibition. There will be a jury for admission, classification, and location of the works sent for exhibition, named by the Promoting Committee.

The Jury of Examination and Awards will be formed of the members of the Promoting Committee belonging to the Jury of the National Exhibition of Artistic Industries and of those elected by the Section of Reproductions. Non-resident exhibitors can take part in the election of the jury through their legal representatives. The prizes or awards will consist of medals of the first, second, and third class, with their respective diplomas. The jury will be empowered to award medals and diplomas to the artists, artificers, and workmen who, although non-exhibitors, may have specially excelled in the execution of the works rewarded, and to recommend them for a proportionate premium. Forms of application for intending exhibitors have been received, and a copy can be obtained on application to the Secretary of the Society of Arts, John-street, Adelphi.

Notes on Books.

A Letter to a Member of Parliament from Mr. William Murdock, in Vindication of his Character and Claims, in Reply to a Recent Publication by the Committee for Conducting through Parliament a Bill for Incorporating a Gas, Light, and Coke Company, London, 1809. Reprinted 1892.

This is a reprint by Mr. Richard B. Prosser of a very scarce pamphlet which has hitherto escaped the notice of writers upon the subject. Mr. Prosser in a Preparatory Note to his reprint writes: —"Murdock was represented before the Select Committee to whom the Bill was referred by Brougham, James Watt the younger appearing as Boulton and Watts' witness. Although it is often asserted that Murdock himself gave evidence, the Report of the Committee shows that this was not the case. The Bill was thrown out, but another Bill was introduced during the next Session and received the Royal assent on the 9th of June, 1810." In 1792 Murdock illuminated his Cornish home with coal gas made in an iron kettle burnt at the end of an open iron tube, and the present year is the centenary of the invention of gas-lighting. The reprint of this pamphlet by the inventor is therefore opportune.

Lessons in Commerce: A Text-Book for Students. By Professor Raffaele Gambaro; revised and edited by James Gault. London: Lockwood and Son.

The author, who is Lecturer on the English Language at the Royal High Commercial School at Genoa, intended his work principally for the use of Italian students. It bore the title of "Lessons on the Laws and Customs of British Trade," and was written in English, with notes in Italian. Professor Gault has made such alteration of the matter as seemed needed to adapt it for the use of English students. The various branches of the subject are dealt with in the following order:—(1) Commerce and trade; (2) mercantile persons; (3) companies and agents; (4) money, weights, and measures; (5) sales generally; (6) customs and warehousing; (7) carriage by land and sea; (8) average; (9) insurance; (10) bills and notes; (11) banking; (12) book-keeping; (13) stocks and stock exchange; (14) bankruptcy. One chapter is devoted to a series of tables of commercial abbreviations.

Encyclopedie Scientifique des Aide-Memoire. Publiée sous la direction de M.

Léauté, Membre de l'Institut. Paris: Gauthiers-Villars et Fils.

Recette, Conservation, et Travail des Bois, par M. Alheilig.

Distribution de l'Electricité. Usines Centrales, par R. V. Picon.

Analyze des Vins, par L. Magnier de La Source.

Thermodynamique à l'usage des Ingénieurs, par Aimé Witz.

Tiroirs et Distributeurs de Vapeur, par A. Madamet.

Le Divers Types de Moteurs à Vapeur, par Ed. Sauvage.

Notions de Chimie Agricole, par Th. Schloesing, fils.

La Bière, par J. L. Lindet.

These are some additional volumes of the engineering section of the "Encyclopédie Scientifique," previous volumes of which have already been noticed in the *Journal*. The different subjects are treated in a clear and systematic manner, and the various headings are distinctly printed. There are no indexes, but each volume has a full table of contents, and a list of books relating to the subject.

A Pocket-book for Miners and Metallurgists, comprising Rules, Formulæ, Tables, and Notes, for use in Field and Office Work. Compiled by Frederick Danvers Power. London: Crosby, Lockwood, and Son.

The author states that the collection of rules, formulæ, and tables which he has made has been found by him to be of use in the actual exercise of his profession, and he therefore hopes that it may be found of like service to others. Amongst other matters, this volume contains tables of weights and measures, and money, weights, dimensions, and properties of various articles, and information respecting heat, electro-plating, electrical units, electro-motive forces of various cells, motors, transmission of power, strength of materials, as well as data connected with chemistry, assaying, &c., mineralogy and geology, ore dressing necessary for the miner and metallurgist, and which can be put in a volume suitable for the pocket. Hints on photography, and a list of poisons, with their antidotes and remedies, are added.

Obituary.

Dr. Forbes Watson.—John Forbes Watson, M.A., LL.D., a member of the Society of Arts of thirty-four years standing, died at Upper Norwood, on the 29th July, aged 65. He was educated at the University of Aberdeen, and appointed to the Medical Service of the East India Company in August, 1850. He was appointed in 1858, by the Secretary of State, Reporter on the Products of India, and Director of the India Museum. He represented India at the International Exhibition held at London in 1862, Paris in 1867, Vienna in 1873, and at the South Kensington Annual Exhibitions 1870 to 1874. He retired from the India-office in 1880. Dr. Forbes Watson read a paper on the "Composition and Relative Value of the Food-grains of India" before the Society of Arts in November, 1857, and in March, 1859, one on the "Growth of Cotton in India." In May, 1860, he read a paper on the "Chief Fibre-yielding Plants of India," and in subsequent years he read several papers on the same subject, the last being on "The Preparation and Use of Rheea Fibre," read in December, 1883. Among other subjects brought by him before the Society were the "Extension of Commerce between the United Kingdom and India, and in the Development of the Resources of both countries by means of Trade Museums," a paper read in February, 1868, and "The India-office Museum Question," a paper read in April, 1875. Dr. Forbes Watson wrote and edited several works connected with the economic products of India, including "Textile Manufactures of India."

General Notes.

Artesian Wells in the United States.—From a recent bulletin issued by the United States Census-office, it appears that the total number of artesian wells on farms in June, 1890, in the States and territories forming the western half of the United States, was 8,097, representing an estimated aggregate investment of 1,988,461·26 dols. Complete statistics concerning the depth, cost, discharge, and other features of 2,971 of such wells, fairly distributed through the various States and counties from which they are reported, have been obtained from the owners, and from the averages derived from such statistics, the number of artesian wells used for the purposes of irrigation is computed at 3,930, the average depth per well 210·41 feet, the average cost per well 245·58 dols., the total discharge of water, per minute, 440,719·71 gallons, or 54·43 gallons per well per minute, the average area irrigated per well 13·21 acres, and the average cost of water per acre irrigated 18·55 dols. Over one-half of these wells are in the State of California, where 38,378 acres of agricultural land were irrigated by artesian water. Utah stands second in the number of artesian wells used for irrigation purposes, and Colorado in the area of land thus irrigated, followed, at a long distance, by Texas and other States.—*Board of Trade Journal.*

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, AUGUST 19, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

OFFICES OF THE ROYAL COMMISSION.

The Royal Commission have received an intimation from Sir Henry Ponsonby that her Majesty the Queen has graciously given permission for the building which is now being erected at Chicago for the headquarters of the Commission to be called "The Victoria House."

EXHIBIT OF FOREIGN WOOLS.

The following letters have been addressed to the Hon. Walker Fearn, Chief of the Department of Foreign Affairs, by Mr. Buchanan, the Chief of the Department of Agriculture :—

Office of the Director-General,
World's Columbian Exposition,
Chicago, Ill., U.S.A.,
July 27th, 1892.

Department of Agriculture,
W. I. Buchanan, Chief.

My Dear Sir,—Through letters and inquiries reaching this office, I am impressed by the interest already evinced among the manufacturers of this country in the proposed exhibit of foreign grown wools, and other animal fibres to be made in the Agricultural Building.

I have assigned adequate space, and am figuring on designs for suitable cabinets for a display of the fleeces of all lanigerous animals, and in this connection beg to invite your attention to the importance of impressing the commissioners of foreign nations from which animal fibres are exported to the United States with the great commercial advantages certain to result from the fullest possible display of their exportable fleeces.

The countries most prominent in contributing to our supply of foreign wools are Australia, including New Zealand; Argentina, Uruguay, and Paraguay, in South America; Cape Colony and Natal, in Africa; Russia, England, Scotland, France, Germany, and Turkey, in Europe; Asia Minor, Arabia, and adjoining eastern countries. Recently, importation of wools from China and East India have largely developed, and met with ready sales among manufacturers of carpets and coarse fabrics.

In the mountainous portions of South America are produced large quantities of hairs from flocks of alpacas, vicunas, and llamas that are in constant demand, as are the fleeces of the Cashmere and Angora goats of Western Asia. As few of our people have ever seen these fibres in their natural state, there is no room for doubting that unusual interest will be taken in their display.

It occurs to me as highly important that the commissioners from each of the countries above named (or, if you think best, those from all foreign countries) should be made aware of the importance attached to the proposed display of animal fibres, and that they be urged to take immediate steps to do themselves justice. I am further satisfied that if the United States representatives in foreign countries can be induced to bring this subject to the attention of the Government to which they are accredited, satisfactory results are likely to follow.

Very respectfully yours,

W. I. Buchanan,
Chief, Department of Agriculture.

Foreign Fleece-bearing Animals.

August 1st, 1892.

My Dear Sir,—Supplementing my letter of July 27th, in reference to a display of foreign-grown wools and hairs, I have the honour to say:

The provisions made in that part of the Live Stock exhibit of the Exposition devoted to sheep and goats contemplate the presence of various unenumerated types of lanigerous animals possessing commercial and historical interest. This feature will depend for its success upon the interest taken by foreign countries taking part in the Exposition, as no premiums are to be paid for such animals.

I have in mind, as likely to be of especial interest to a large class of visitors, the fleece-bearing animals of South America. That is to say, the Mestiza sheep of Argentine and those of the Valley of the Rio Dedo Plata that produce coarse or carpet wools, also representative animals from the best fine wool-bearing flocks of Australia and of the cross-breeds of New Zealand. The flock products of all these countries have for some years supplied the severest competition that domestic growers have encountered in the home market, and I feel certain that extraordinary interest would attach to the presence of typical animals from which these competing wools are taken.

In Russia, Asia Minor, and throughout most of the Oriental countries, are numerous flocks of sheep of primitive types from which are supplied most of the sixty to eighty million pounds of carpet wools

each year imported into the United States. In view of the important commercial interests involved in this trade, I have confidence that typical animals of all the ovine races in eastern countries where our Government has representatives can be secured through the kind interest of foreign Commissioners to the Exposition, or our ministers.

In the mountainous sections of South America are herds of the alpaca and its congeners, the vicuna, llama, &c., many of which are made to serve the triple purpose of supplying fleeces for fabrics, furnishing meat for sustenance of the people, and doing duty as pack animals under conditions where even the ordinarily safe-footed mules cannot be utilised. In view of the cordial relations existing between this country and its South American neighbours, and the zeal with which these governments have responded to the invitation to join in the Columbian Exposition, I am confident that their Commissioners will be glad to send here from their countries one or more pair of their fleece-bearing animals.

Both Angora and Cashmere goats are liberally provided for in our premium list, and there is no room for doubt that the principal herds in this country will be well represented. It is greatly desired that alongside of these representatives from domestic herds we should also have specimen animals from the parent herds of Persia, Turkey, and other habitats of these useful animals.

I will be glad to provide necessary space, forage, and attendance for such animals above referred to as may be delivered to the Live Stock Department of the Exposition by foreign nations participating.

This department will be grateful for an early consideration of this subject by foreign Commissions interested, and respectfully asks for an early, and I trust, favourable reply.

Very respectfully yours,

W. I. BUCHANAN,

Chief, Department of Agriculture.
(In charge, Department of Live Stock.)

Proceedings of the Society.

CANTOR LECTURES.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

By PROF. GEORGE FORBES, F.R.S.

Lecture I.—Delivered January 25, 1892.

INTRODUCTORY.

In 1885, I had the honour to deliver a course of lectures here on the "Distribution of Electricity." This followed a long paper I had read to the Society of Telegraph Engineers on the "Heating of Conductors," when I got out tables for practical electricians of the sizes of wires to be used with different electric currents to prevent overheating. Up to that date, the distribution of electricity had been but little studied, and numerous serious mistakes were being made. My object at that time was to lay down in clear language the scientific conditions which must underlie any scheme of distribution. At that time, the more modern plan of using high tension alternating currents was hardly developed, and the advocates of high tension were engaged on storage batteries, and on various parallel-series systems, which introduced the high tension actually into houses.

When I arrived at the conclusion that, for a central station supplying 100,000 lamps, the copper conductors leaving the central station must, on the most economical principles, be equal to two cylinders of copper, each equalling the thickness of a man's body, it seemed that low tension was doomed.

No single invention of any importance has added to our facilities in low tension distribution, so as to affect the dimensions of the conductors, and yet low tension distribution has done much solid work on a large scale. When asked by the Council of the Society to give a course of Cantor Lectures, I felt that, at the present date, I could not do better than supplement my previous course, and bring my work on electrical distribution up to date; and it will be well also to examine the reasons why the objections which formerly existed against low tension distribution have so far been overridden, that millions of pounds sterling have been invested in it.

The present course of lectures is intended primarily for electrical engineers, and it is to them that my principal remarks will be addressed, but there are many present who have no intention of putting what they hear to practical use, and it will not be out of place if I indicate briefly some of the points that have to be attended to in electrical distribution.

The resistance offered by conductors to the electric current causes two sources of trouble. One is that energy is absorbed and wasted, and this may seriously affect the coal bill and the total machinery required in the central station. The solution of this difficulty is naturally to reduce the waste by reducing the resistance of the conductors. This means that we are to use larger copper conductors. But this increases the cost, and it is clear that there is a definite most-economical size, such that, if the con-

ductors are increased in size, the increased interest on capital expenditure swells the cost; and if we diminish the size, the extra machinery required increases it, and the coal bill rises. It is an important function of the electrical engineer to determine in every case this most economical size of conductor. Large experience has generally led to finding the most economical size to be such that the current density shall be not more than 500 ampères per square inch. The other trouble is that when many lamps are in use, and a large current is flowing, the electric pressure is reduced and the lamps are dim. The further distant a lamp is from the central station the lower is its pressure, and the difference in brightness of lamps is particularly observable in the distant lamps. Those near the station suffer no loss. To increase the brightness of distant lamps during the busy hours, the pressure at the station may be slightly raised. Thus we generally find in central station distribution that in the busy hours lamps near the station are brighter than usual, and the distant ones are more dim. This is well shown by diagrams of pressure taken on different parts of distribution mains by self-recording apparatus. This solution of the trouble does not go far, however, as we cannot allow a large variation of pressure in any lamp. The Board of Trade at present allow the large fluctuation of 8 per cent., and it is to be regretted that the supply companies generally avail themselves to the full of this latitude. This is shown by recording volt-meters.

For further improvement in the supply it is necessary to introduce feeders, which are conducting wires going from the central station direct to certain points on the network of distributing mains, where the variation in volts is found to be large. No lamps being connected on to the length of these feeders, the full pressure can be supplied at the point of distribution without other lamps being raised in pressure.

I do not intend to pass further in review the general principles of low tension distribution. The problem and the rules to be followed were completely worked out in detail in my previous Cantor Lectures; and after these seven last years of busy work, I have not one word to alter in all that I said at that date.

Nor have I the intention in the present course to do what might be an interesting proceeding, viz., to describe the various central stations which have been erected in these years, and analyse and criticise their modes of working. Some of the stations with which I have myself been connected as consulting engineer have been low tension and some high tension, and it might have been thought desirable that I should give you the results of my own experience. Moreover, as is well known, I have largely devoted myself to a careful study on the spot of a large proportion of the central stations both in Europe and America, and I might easily have found materials in this experience to occupy a few evenings with profit. I have, however, other aims in these lectures, and descriptions of central stations are not wanting to those who are sufficiently interested in them. I have myself given full details of the machinery and methods employed at some of the great European stations in a paper read before the Institution of Electrical Engineers in 1889. A very interesting account of central stations in Germany, by all the best manufacturers, was brought out in a handbook published last year at Frankfort for the Exhibition.* My desire is to carry into these lectures the same spirit that led to my previous Cantor Lectures, and to bring before engineers the points that require attention to make our work as perfect as possible, and to draw attention to the lines in which we may hope to overcome the great drawbacks which still hamper the industry, and prevent it from furnishing such economical results as the general conditions of the problems warrant us in expecting. It will, I hope, be found that there are engineering resources at our call which have yet to be invoked before we have reached the final solution of the problems.

As an example, I will point out to you one or two facts in the economy of the subject. One is that central station distribution, as distinguished from isolated plants, involves a huge additional expense in distributing mains. The cost of these must, from the nature of the case, be out of proportion to their earnings until the consumers are much more closely packed than at present.

Another fact is that our machinery is lying idle three-quarters of the year, and earning no dividend. A third is that, owing to the limited period during each day that the maximum demand exists, we waste fuel in heating up most of our boilers for only a couple of hours' work in the evening. A fourth point is that, owing to the irregularity of the demand, we waste a a great deal of steam by working our engines much under their full and economical load.

* Die Versorgung von Städten mit Elektrischem Strom.

All these points will be fully elaborated in the lectures. The net result is that electricity in London costs twice as much as gas, that it costs more to obtain it from a public supply than when manufactured (for a large establishment) on the premises, that the method of debiting consumers is unfair on those who have the longest hours of working. You must not be deceived by the optimistic calculations of enthusiasts and interested parties. The electrical industry has nothing to fear from competition, and the surest way of gaining the confidence of the public, and of making sound progress, is to openly accept the true state of the case, and acknowledge the difficulties that hamper you, and then apply all the skill at your disposal to overcome these difficulties. In illustration of the points I have raised, I will here only state one or two points.

1. The streets in London are not lighted generally as they ought to be by arc-lights. We know, from a most extensive experience, that anyone can set up a circuit of ten ampère arc lamps with underground mains, and run them with good profit at a rate of £30 per annum, during all the hours that gas lamps are now used (4,000 hours per annum). The cost of the mere current for these from a supply company, at 7d. per unit, amounts to £58 6s. 8d., double what it would be if privately worked.

2. A careful comparison of the cost of lighting the Athenæum Club with its own machinery, which has been done for many years, with the charges from a supply company at 7d. per unit, shows that the present cost is £894 per annum, including depreciation on machinery costing £1,608, as against £1,452, which the company would charge us.

We must fairly recognise the fact that electricity is twice as dear as gas, and also that where we replace gas by electricity we must increase our expense in warming a house. When this has been granted, we must remember that we save much in decorating and in preserving our books, that we abolish vitiated and dirty air, and that we can keep our rooms cool. These are sufficient recommendations for those who value cleanliness and health, and will spur the ingenious among us to remove the confessed drawbacks.

In order to perfect our systems of distribution in practice, we must keep before our minds the ideally perfect, and depart from that course only at the gain of decidedly practical advantages, and we shall often find that, if due caution is exercised, we can gain much by very slight departures from the ideally perfect. This is the spirit which has actuated the evolutionists of the modern dynamo, and which enables us to be proud of our 96 per cent. efficiency, while the steam-engine, with a hundred years of brain work and millions of money spent on its development, has reached only 80 per cent. efficiency in its mechanical working. Had it not been for the scientific men who took up dynamo construction at the beginning, we would have rested content with the 50 per cent. efficiency originally offered by Brush and others in machines which were thoroughly well designed mechanically, and did their work thoroughly, if uneconomically. At first, designs of complicated character were introduced, in which the rapidly revolving parts, those requiring most mechanical strength, contained only the following materials:—An iron spindle, a wooden hub, and an armature made of iron wire, wound with copper wire, the parts being joined and separated by millinery and paper and sealing-wax. The object of this construction was to minimise the losses. One weak part after another was discarded, until we now have a fairly strong and mechanical armature.

So in electrical distribution. Ten years ago we searched for the ideally best. In each case we made elaborate calculations of the probable consumption in different parts, and we tried to average the relative size of feeders and distributing mains and their points of connection as accurately as possible. We tried to select those points for attaching feeders that would use the least copper, and we tried to devise means of regulating electric pressure in the feeders, so as to waste no more copper or electric energy than was absolutely necessary.

Ten years of practice in central station working has now stereotyped our practice a good deal; and while we do not always lead a conducting wire by the shortest route from each lamp to the central station; and while we do not always attach a feeder to the nearest part of the district it has to feed in normal conditions, still we always have these leading principles in mind while laying out a plan of electric mains, and we readily adopt the general average results of our experience in past work to simplify our system.

Central Station Supply *versus* Isolated Plant.

At the date of my previous Cantor Lectures

the great question before our minds was whether central stations were economical. It was obviously far more convenient for the public to be supplied from a general source than for each one to generate his own electricity; in fact, the latter plan would be impossible, except in the case of large establishments. It was further obvious that the cost of both labour and coals in small plants would be far greater than in a central station. But the fact remained that, with central stations, we had all the additional cost of mains run through the streets, involving enormous cost, not only in copper, but also in taking up streets, finding a way among all the underground pipes, and making all good again. We had just learnt, from the experience of the telephones, that the more subscribers there were after a certain limit, extending to greater distances, the less dividends could be paid. Consequently, there were many men at that date who did not think that central stations could compete against isolated plants for even moderate-sized establishments, and who saw no prospect of small consumers being supplied, except by neighbours clubbing together to generate electricity for themselves.

Fortunately the verdict has hitherto generally been that current *can* be economically generated in, and distributed from, central stations, and the proof is in the enormous ramification of electric circuits now occupying the beds of the streets of London. I do not know the case of any town in the world where such enormous progress—designed for permanency—has been made in so short a time. From 1882 to 1889 the legislative enactments restrained and held, as in a leash, the spirit of the age (which is electrical). In the last-named year, Major Marindin, acting for the Board of Trade, held the great enquiry in London, besides minor ones in other towns, as to what powers were to be granted to what companies. From the moment that his reports were accepted, the forces which had so long been restrained burst forth, and the pioneers, like released greyhounds, darted after their prey, and the whole place was in the hands of the electricians. All the work was well done, and will remain; and we may well be proud of what has been accomplished.

But while thus congratulating ourselves, we must not overlook the fact that we are prevented by several causes from supplying electricity so cheaply as might be hoped. I have already given you the figures with respect to one large club, and I could give you many others to show that at present, for a large establishment using light for long hours, an isolated plant is the cheaper. It is particularly to be remarked that the average number of hours that a light is in use is barely two hours a day. Hence, during the greater part of the twenty-four hours, the mains in the street are lying practically idle, the boilers and engines are earning no dividend, while the managing staff would have no more work if all the customers used the light for longer hours. Hence, during the greater part of the day, the cost of producing an additional electric Board of Trade unit is little more than the cost of the coal, certainly not 2d. a unit, while for a few hours in the evening it is at least three times as much. You see, then, how hard a fixed price per unit is on clubs and other places where a steady large supply is wanted for long hours. This is one reason why the public supply to the Athenæum Club would cost £500 more than the cost of making it on the premises. This is why the cost of an electric arc-lamp for street-lighting would be double what it would if not obtained from a supply company. If we had any means of supplying electricity for a short time as cheaply as at the full output all the twenty-four hours, we should reduce the selling price to one-third of what it is now.

Electricity *versus* Gas.

At the present time, electricity in towns often costs twice as much as gas, and it is not everyone who can see that the gains counterbalance the extra expense. It certainly saves expense in decoration, it is far more healthy, and in valuable buildings like the British Museum, it alone can be permitted, as giving absolute immunity from fire where properly carried out. The same remark applies to all private houses. When a curtain or a dress is blown by the wind or otherwise brought into contact with a gas jet we have a fire. When this happens with an incandescent lamp we have absolute immunity. But by taking advantage of the facility of putting out a light in a bedroom when done with, great economies can be effected in careful households. There is one case in which electricity beats gas and other illuminants, not only in cleanliness, health, and security from fire, but also in economy, and that is in country houses. I could bear this out by numerous examples. One large old castle in Scotland, where the risk of fire was great, and the electric light was introduced primarily for security from fire,

offers a good example. Here there are 210 lights of 16 candle-power installed, the house has always been full, and the lights much used. The installation cost £1,800, and last year, the second of working, an accurate note of all the expenses, labour, coal, &c., comes to £75. Nothing approaching to this could have been got from gas manufactured on the premises, and, at the rates charged by supply companies, the cost would have been over £300.

Feeders and Distributing Mains.

The satisfactory working of a central station depends largely on the proportion that the feeders bear to the distributing mains. Some stations have been started by persons quite incompetent to do the work, and have no feeders

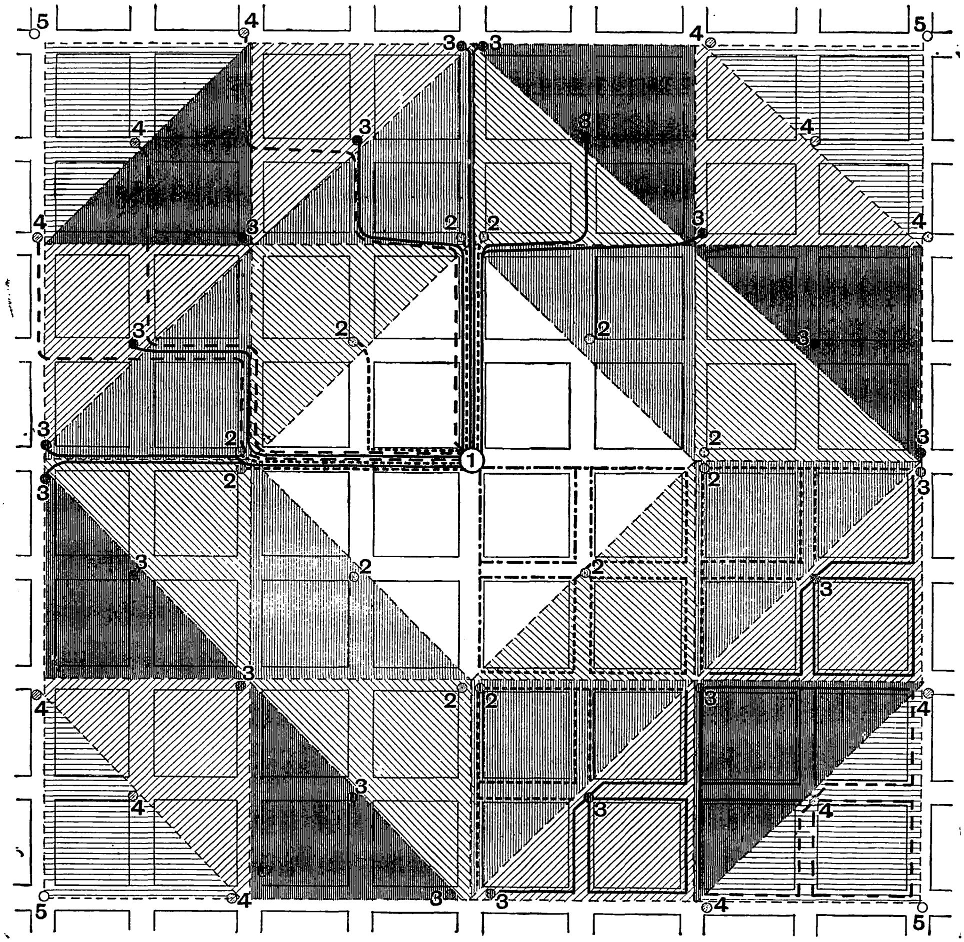


Fig. 1.

at all. The consequence is that we have enormous variations in the pressure at different times. I believe that at Brighton there is at times of maximum working a difference of pressure in lamps on different parts of the circuit amounting to 25 volts, and instead of applying the well-known engineering methods, it has been attempted to patch it up by putting lamps of different voltage on different parts of the system. When such a thing is attempted, except for the correction of a very few volts, we are landed in worse trouble. I would draw attention to the diagram on the wall (Fig. 1) representing the plan of an American city like Philadelphia, and showing the way in which the feeders and distributing mains would be run for lighting the city with economy, and confining the variation of pressure all over it within the same limits. The centre square, shown white, would have no feeders, but be

divided up into four triangular-shaped districts, each being supplied by mains from the central station. The part between the feeding points marked 2, and those marked 3, would be divided up in the same way into triangular-shaped districts, and each have its own feeder, and distributing mains starting from a No. 2 feeding centre; and so on for the districts outside these. It will be noticed that all the distributing mains starting from the feeding points are of equal length, if measured along the streets, as shown at the bottom right-hand corner of the diagram. The circuits being run in this way, a network may be formed by connecting the ends of the distributing mains together wherever close, and whichever district they belong to, since the pressure at these points will always be nearly the same, assuming the same current density in all the distributing mains, of course. I sent out a circular lately to try to find out how far the benefit of feeders was appreciated in our central station engineering, but very few supply companies cared to give the information. I find that the Kensington and Knightsbridge Company have—

	tons.	cwt.	qrs.	lbs.
Total weight of mains........	133	11	3	5
Total weight of feeders........	15	10	3	0

in a total length of street covered = 12 miles 835 yards; partly copper strip, insulated by glass insulators, supported by oak bars, being used; and partly vulcanised rubber cables run in iron gas pipes coated with Angus Smith's composition.

The cost for straightforward work under foot pavement, including material, wages, superintendence, digging, and carting away, but not tocls and spare plant, is stated to be—

	Per Yard. £	s.	d.
5 pipes, 4 of 2-in., and 1 of $1\frac{1}{2}$-in., with 3 cables $\frac{61}{15}$s, and 2 cables $\frac{37}{10}$s.	3	2	2
3 pipes, 2 of 2-in., and 1 of $1\frac{1}{2}$-in., and 3 $\frac{61}{15}$ cables	1	8	$6\frac{1}{2}$
15-in. culvert, including 3 strips 1-in. × $\frac{1}{4}$-in.	1	3	9
20-in. ,, ,, 5 ,, ,, ,,	1	9	0
24 in. ,, ,, 7 ,, ,, ,,	1	14	2

The number of lamps supplied up to January 6th, 1892, is equivalent to 38,680 of 8 candle-power.

The horse-power available is—

Kensington-court	1,070
Chapel-place	700
	1,770

The total capital invested in mains of all kinds, including copper and cable, is 33 per cent. of £133,000, the total paid-up capital; in machinery and buildings, 43 per cent., and in batteries 10 per cent.

At Chelmsford, with alternating currents, overhead wire is generally used, $\frac{3}{4}$ ton for street lights, $1\frac{1}{2}$ ton for secondary wires, and 1 ton for primaries for private lighting. Indicated horse-power in station, 300; total outlay, £14,000. Lamps, 220 of 32 candle-power, 1,000 of 8 candle-power for private use, 19 arcs of 10 ampères, and lamps in works using 180 ampères and 110 volts. Welsh coal per unit generated, 8 8 lbs.; efficiency of an engine and dynamo, 75 per cent. (mean).

The Westminster Electric Supply Corporation's distributing mains are estimated roughly at two to two and a-half times the weight of the feeders. The total capital of this Corporation is £300,000, the total indicated horse-power in central stations 3,500, and the number of lamps supplied equivalent to 66,000 8 candle-power. The cost of mains and underground work is roughly £150,000, and the total length of pavement opened up is 53,640 yards. In places, the mains consist of bare copper in concrete culverts; but the Corporation have by far a greater length of insulated cable laid in Callender casings.

The Northampton Electric Light and Power Company have equal weights of distributing mains and feeders. The capital invested in mains is 42 per cent. of the total capital of the company, the length of mains 2,800 yards, including 350 yards of feeders only, and the total weight of copper 16 tons. The mains consist of bare copper in Crompton culverts, where possible; Henley's AA cable in 2-inch iron pipes at road crossings, &c.; Fowler-Waring cables, lead-covered, laid in half glazed-pipes with sand, and covered with concrete, and Callender cables in iron troughs and bitumen, for isolated feeders. The average cost of mains is 45s. per yard. The indicated horse-power at work is 240; 120 additional being on order. The number of 8 candle-power lamps supplied, 33,000. The proportionate cost of buildings and machinery, &c., to paid-up capital is—buildings and machinery, 46 per cent.; land, 5 per cent.; the paid-up capital being £15,000.

Another company, with paid-up shares and debentures = £73,585, whose expenditure on mains is £17,440, has 20 miles of cable in 6 miles of street, consisting of $20\frac{1}{2}$ tons of copper for feeders, and 28 for distributing

mains. Actual cost of supplying and laying Callender-Webber casing with three 2-inch ways, including all charges, with straightforward work = 6s. 6d. per yard, or including the draw and service boxes, 8s. 9d. per yard run. The lamps = 28,000, of 8 candle-power; and there is 830 horse-power in the central station in the shape of steam-engines alone.

The Allgemeine Elektricitäts Gesellschaft has over 700,000 metres of copper, weighing 1,500 tons, nearly all in Siemens' armoured cable, costing from £2 to £4 10s. per yard. This enormous mass of copper accounts for the splendidly constant pressure always maintained in the network.

The Secteur Clichy, in Paris, cover 26 kilometres of street with 31 kilometres of feeders and 121 of distributing mains.

The cost of laying 3-inch iron pipes in cement in New York, with man-holes 7 feet deep, 8½ feet square inside, with 12-inch walls of brick in cement, depends on the number of ducts, and is as follows:—

No. of Ducts.	Dollars per Duct per foot run.	Shillings per yard.
2	1·91	23·92
4	1·11	..
6	·85	..
8	·71	..
10	·63	7·56
12	·58	..
14	·54	..
16	·51	..
18	·49	..
20	·47	2·4
24	·44	..
30	·41	..

The average cost of a house connection, from a large number of actual cases, is $66·02, say £13.

These special cases are given as a small contribution to the general question. My own general experience is that mains ought to cost, on the low-tension system, about half the capital of the company, about equally divided in distributing mains and feeders. I think that far more copper would be put down in mains if people realised the low rate of interest at which money could be raised in debentures on them.

Experience is the best guide as to the proportion between feeders and network mains. The smaller the latter, the more numerous must the former be. The distance that can be covered by a feeder depends on many things, but firstly on the variation in pressure allowed at the house connections. The Board of Trade, wisely I think, has given great latitude, 4 volts either above or below the normal 100 volts—*i.e.*, an 8 per cent. variation—but it is to be hoped that supply companies will find it to their interest to attain a higher standard. If the feeder point is kept at a constant pressure of 100 volts, the 4 volts will be lost in 80 yards if the section of copper is based upon a current density of 1,000 ampères per square inch, or in 240 yards if 330 ampères per square inch is chosen; and I am glad to say that in this country a large section like this is recognised as the best design. If now we use a three-wire system, we can go to twice the distance, or 480 yards, with a current-density of 330, still with a maximum drop of 4 volts. If the pilot wires which indicate pressure be not at each feeding point, but half way to the most distant lamps supplied by a feeder, the length of main which can be fed is again twice as great, or 960 yards, the lamps at the feeding points varying from 100 volts at times of small demand, to 104 at the maximum, the lamps at the distant end varying from 100 volts at times of small demand, to 96 at the maximum. If now the lamps at the feeding points be 104-volt lamps, and those at the distant end 96-volt lamps, with graduated voltages at intermediate points, we can increase the length of main supplied by a feeder to 1,920 yards, and no lamp will have a greater variation than 4 volts above or below its normal value. Of course this result has never been attained in practice because in most cases it is difficult to accomplish. I do not generally approve of using lamps of different voltage on a circuit. The only time I ever sanctioned it was when I settled what was to be done by the St. James's and Pall-mall Company. Here the district was so compact that I could see easily that we would not be bothered by the future extensions. There is also some trouble in putting the pilot wires in the place indicated. There is also some difficulty in arranging the feeders so that they all feed into the network at the required pressure. Some engineers are also afraid of the three-wire system, having had no experience of its use. And, again, in a badly-fitted station, it is difficult to ensure that the engines are working quite uniformly, so that a 2 per cent. variation, up and down, may be all that can be calculated for in order to conform with

the Board of Trade requirements. All these reasons may reduce the workable distance, even when the low current density here assumed is taken, from the above 1,920 yards down to 240 yards. I wish to impress strongly on you the fact that there are four distinct methods of improving the distribution—(1) increasing the regularity of the engines, (2) using the three-wire system, (3) putting the pilot wire connections half way between feeder points, and (4) varying the voltage of lamps according to the distance from a feeder point. The last is the only one which cannot be safely done in all cases, and each of these four remedies enables us to go to double the distance, the introduction of the three-wires being the only one which increases the weight of copper a little; or we may say, especially with relation to the position of the pilot wires and the voltage of lamps, that these remedies each halve the weight and cost of copper in the mains, and, combined, reduce it to one quarter. The practical objection to using lamps of different voltages is that generally the network is first laid down and the feeders added in greater number as the demand increases, hence the voltage of lamps in any house will be changed. But the improvement on existing methods which I have advocated, of putting the pilot wire attachment half-way between feeder points, saves half the copper and can always be applied.

Management of Feeders.

In the central station the arrangements for supplying the feeding points with the same pressure are not always satisfactory. It has been customary in many cases to make the resistance of each feeder the same, so that when the same current is flowing in each the fall of pressure along the feeder is the same. Other people use adjustable resistances to regulate the pressure. In both these cases omnibus bars can be used to connect all the dynamos in parallel and all the feeders in parallel. This is very wasteful. Another plan is to use the dynamos at different pressures, and group the feeders on them according to their requirements. This is perfect in theory, but difficult in practice. It involves frequent shifting of a feeder from one dynamo to another, and it involves engines running at low loads. Another plan has been suggested, to put in a few secondary battery cells in the feeders in place of resistances, some to raise and others to lower the pressure, according as they assist or oppose the current. The two volts given by such cells is a convenient unit for such a purpose. The best plan seems to me to be one which has not hitherto been adopted. Connect all the dynamos in parallel on omnibus bars. Between this and the feeders put switches, by means of which one or more low-tension dynamos (of two volts say) can be switched in to assist or oppose the current. I would not suggest this were I not now thoroughly satisfied with the low-tension non-commutating dynamos with which my name has been connected. To show their suitability, I will merely record an experiment with one of these dynamos used with a Parsons's steam turbine. The armature was merely a solid bar of wrought iron, 3 inches in diameter, and it rotated between two magnet poles, which enclosed it, at a speed of 24,000 revolutions a minute. With this we welded pieces of iron $\frac{5}{8}$-inch diameter, and then heated a rod of $\frac{5}{8}$-inch iron, 15 inches long, to a white heat for an hour and a half, and everything was working quite smoothly, and could have gone on like that for twenty-four hours. The E.M.F. on open circuit was four volts, and on closed circuit two volts.

Loss in House Wiring.

I hope that, before long, the Board of Trade will reduce the variation now allowed of 4 per cent. up and down to half this amount. There is always a certain loss of pressure in the house wiring, which ought never to exceed two volts. But as householders seldom engage an electrical engineer to protect their interests against the contractors, the latter generally use thinner wires than is right, and so reduce the pressure in the lamps still more. A variation of more than 2 per cent. from the normal pressure at the lamps is very objectionable in practice, though I suppose we must put up with it for some time.

Recording Voltmeters.

I will now show you some results of actual work. I have on the table one of the recording voltmeters made by Messrs. Richard Frères. It is like the well-known recording aneroids. A cylinder is revolved by clockwork and carries a ruled sheet of paper; while the paper travels horizontally, a voltmeter causes a pointer filled with ink, and just touching the paper, to rise and fall with the electric pressure, and thus we get a continuous record of the pressure which a house is receiving from the supply com-

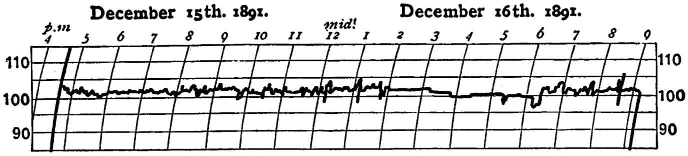


FIG. 2.

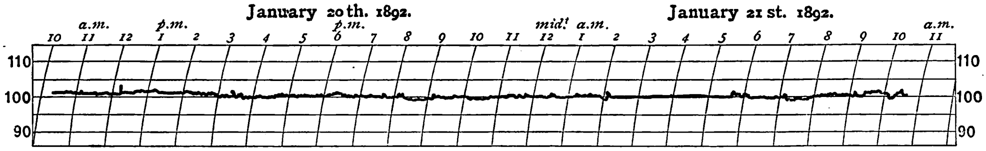


FIG. 3.

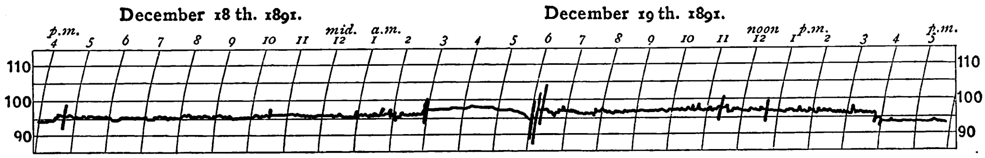


FIG. 4.

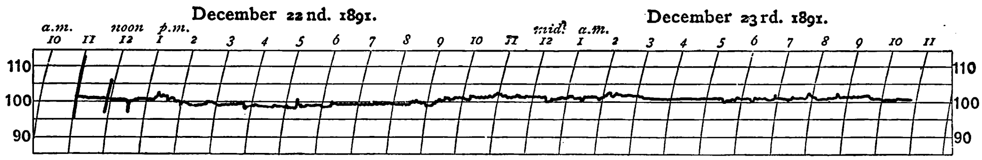
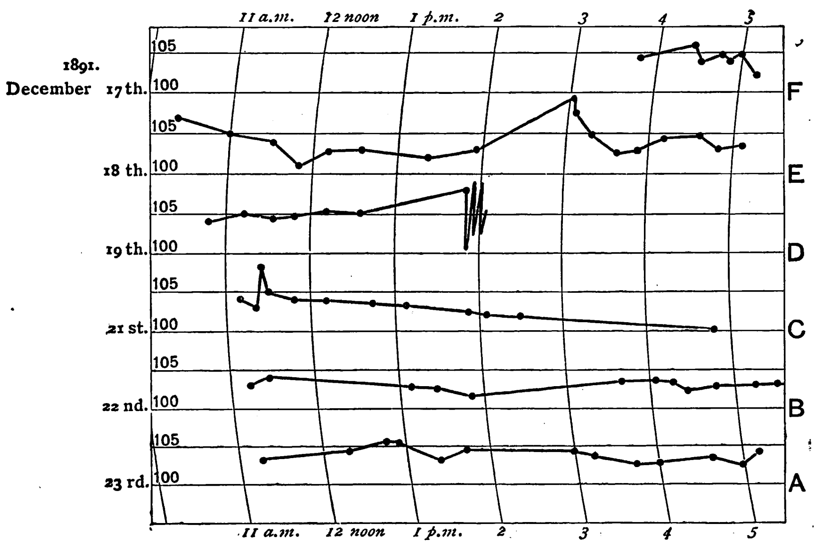


FIG. 5.



The divisions AB, BC, CD, DE, EF respectively represent 10 volts each.

FIG. 6.

pany. This instrument is very convenient and useful. The one I have been using is made to work up to 120 volts, and its range of greatest accuracy is at half this pressure. The controlling force of the magnet is weak at 100 volts and the friction of the paper comes into play to diminish the actual irregularities. Still I have been able to obtain interesting curves in a variety of places; and I wish to draw the attention of administrative bodies like the London County Council to the necessity of using such instruments in the interests of the community, and as the only real check upon the supply companies. The instrument which I have used reads low at 100 volts. I have a number of curves taken at four places on the mains of one supply company, and except at one place they come out very nicely, only we must remember that the full irregularities are not shown by this instrument. The places of which records are shown are my office, at 34, Great George-street, 39, Victoria-street, 13, Ashley-gardens, and the Scottish Club in Dover-street, Piccadilly. [Some of these curves are here reproduced (p. 870). Figs. 2 and 3 are records taken at my office in Great George-street; Fig. 4, one taken at the Scottish Club; and Fig. 5, one from Ashley-gardens.] To show the real irregularities, I have added drawings from actual observations at frequent intervals of an accurate voltmeter, when you see (Fig. 6) that the pressure in my office is always high, and sometimes reaches 109 instead of 100 volts. Of course this is very destructive to the lamps, and renders the company liable

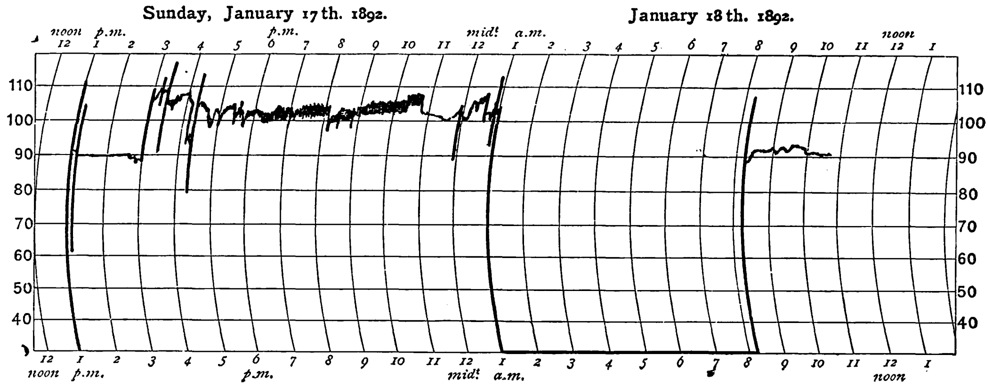


FIG. 7.

to fine. The pressure at this part of the distribution system is always too high, and apt to injure the lamps. At Dover-street, on the other hand, the pressure is always too low, and the illumination is bad. When the busy evening hours come on, the pressure at Dover-street always falls. The influence of a fog is shown in the same way. It is not to the interest of a supply company that such defects should go on. While exhibiting these curves, I add one taken at the Athenæum Club (Fig. 7), which is supplied by a gas-engine and dynamo of its own, with accumulators as regulators, and for use during slack hours. Notice the violent irregularities, simply owing to the carelessness of the attendant, and also notice the effect of the pulsations of the gas-engine, showing a pulsation of 2 or 3 volts, which goes on every second or half-second, and is most trying to the eyes.

FIVE-WIRE SYSTEM.

The evident advantages of the three-wire system can obviously be extended to a greater number of wires, if we do not object to bringing the higher electric pressure into our houses and up to the lamps. This has been done with five wires, by the company lighting the Secteur Clichy at Paris, and in other places. Since five wires here take the place of eight, the advantage is greater than when three wires take the place of four. By using it we can also go to twice the distance of the three-wire system. I shall have something to say about this method in my next lecture, to which it is more suitable.

BATTERIES.

I must conclude this part of my subject with some mention of a class of electrical apparatus which has been improved more than anything else in connection with low-pressure supply since I gave my previous Cantor Lectures. The position which I then took up was this, that there was no plan for electric lighting so satisfactory as the secondary battery plan, but it was hopeless to think of it until one important element was invented, namely, a practical secondary battery. That *desideratum* is much nearer realisation. In the last ten years dynamos have been much improved, and so have lamps, but in no branch has the improvement equalled that in secondary batteries.

These improvements are partly in the way of making the plates more substantial, and less liable to buckle or scale, or for the pellets to drop out, and partly in their management, the chief step in the latter direction coming from the discovery that batteries will stand any amount of overcharging, and really improve in the process, and also that they should never be allowed to run down, and that low specific gravity should be remedied by persistent overcharging, recourse to adding acid being only resorted to at rare intervals. To keep batteries in a high state of preservation in this way involves great expense, from the frequent overcharging, and also from the fact that, if we never take much out of the battery, we must have a larger outlay in them to do our work. At the present time, the only objection to batteries is their expense, and that is now far less serious than six years ago, when their life was very short. Secondary batteries are often called accumulators, or storage batteries, according to the purpose for which they are wanted. They are used for five different purposes—(1) As regulators; (2) to replace dynamos, and give workmen a rest at idle hours; (3) to add to the total out-put of a central station at a time of maximum demand; (4) as a reserve in case of breakdown, and (5) to transform down from high pressure in the streets to low pressure in the houses. All these are most useful purposes and seem so desirable that many companies have adopted them even at a greater cost of supplying the electricity. Of course you will always find the manufacturers of any such special plant saying that it does not increase the cost to use it, and when, as often happens, the manufacturer acts also as consulting engineer, you may expect the use of such plant to be more extensive than their costliness warrants. This has been the case in England in many cases, but it is not to be regretted by the general public, because these cases have given us much valuable experience. In this year, 1892, however, the improvements in storage batteries are such that it hardly costs anything more to use them than to do without them, and we see the desirability for storage of some kind in our central stations so much in actual working, that we may hope the time will soon come when some kind of storage will be possible for a large part of our generating plant, so that we will not require to fire up a lot of boilers just for a few hours work. When a battery is put across the mains at the central station it acts as a regulator, and keeps the current steady in spite of irregularities in the engine. This ought not to be an important point in central stations, but it is in isolated plant worked by a gas-engine. The battery in the central station, however, offers a splendid means of regulating the pressure in the feeders, which can then be supplied at any pressure with current, and the size of copper can then be chosen to fulfil the economical law of being proportioned to the current, and not to the barbarous law of making the resistance of all feeders equal. Much discussion has arisen about the value of accumulators in central stations, but it is remarkable that, up to the present time, the one great advantage has been overlooked, which is that you can use them in shunt on the mains as a means of regulating the pressure supplied to feeders. This action is the only solution that has been tried which gives perfect satisfaction. I do not believe that the introduction of accumulators into a central station has ever introduced economy, but in many ways it leads to a better service, and in no way more than in this which I have just indicated. So much is this the case that, except in the few cases where economy overrides quality of light, or in some cases where a fall of water is the source of power, I do not think that any low-tension continuous current central station on a large scale is complete without a small supply of accumulators. The other use of accumulators as transformers of high pressure into low pressure belongs to the subject of my next lecture.

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CANTOR LECTURES.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

By Prof. George Forbes, F.R.S.

Lecture II.—Delivered February 1, 1892.

In my last lecture I urged the importance of not slurring over the actual difficulties that are before us. We are looking at the question of distribution from an engineering point of view, and it is desirable always to face the difficulties and see our way as far as possible, rather than to slur them over and pretend that they do not exist. Now, I pointed out the chief causes of excessive expenditure in electrical distribution through towns. They are two—first, the cost of distribution; second, the cost of generation. In both of these cases of production and distribution the expense is greater than it would be if we were producing it for our own purpose at a constant rate. Distribution is particularly expensive at the present moment, because there is only a small number of houses connected. Mains are being laid through great lengths of street, and perhaps only one in thirty houses is taking current. That will mend as time goes on, and that cause of excessive cost will diminish in consequence. The other great source of expenditure that any supply company has to face, lies in the fact that electricity is not wanted uniformly throughout the 24 hours. This is, perhaps, the most important point to which attention has been drawn of late years in the question of distribution. It injures us in two distinct ways — first, through our engines; secondly, through our boilers. Owing to the fluctuating demand for light, we are compelled to vary the number of engines which are working to supply the mains; and employ the engines sometimes at below their economical load, and that is extravagant. Besides this, the boilers consume more fuel than if a continuous supply is given, because so much coal is spent in heating them up in the evening. With regard to light loads of engines, few people realise what enormous loss there is when we are running powerful engines at light loads, more especially compound engines. It is quite possible that a 100 horse-power engine, which would be consuming (say) 22 pounds of water or steam per indicated horse-power per hour when running at full load, would, running at light load —one or two horse-power—be consuming as much as 600 pounds of steam per horse-power hour. This great source of loss could be got over by having the units in the way of engines tolerably small. The smallest size of engine is efficient, so that by employing a number of them, and putting them on in turn, we never have much loss through under-loading; but with respect to boilers, we are without remedy at the present time. Great attention was drawn to this point in the paper read by Mr. Crompton before the Institution of Civil Engineers last year, in which he introduced the term, "load factor." Load factor is a very important thing, but the one peculiar thing about it is, that no one knows what it is. Mr. Crompton introduced five distinct definitions of the load factor, each of them giving a totally different meaning to the other cases where the words are used without alluding to what is meant. I will give you a series of definitions, which, I trust, will suffice for the future. I had hoped that Mr. Crompton would have given us an exact definition, but he has failed us in that, and, therefore, I will give you what I think will be sufficient for engineers.

I will draw attention to these diagrams which belong to the Berlin station.* The heavy load lasts only for a few hours. The thick white line indicates the load which is passing out. During the winter months, at about six or eight in the morning, a small peak is shown. There is nothing else till the afternoon, when it rises to its maximum. The same general features prevail throughout the year in the different months, except in the mornings of the summer months, when the demand for

* These diagrams are published in a paper read by Professor George Forbes before the Institution of Electrical Engineers, 28 February, 1889, on "Some Electric Lighting Central Stations in Europe, and their Lessons."

current ceases, and in the summer months the height of the peak diminishes, and the number of hours. Similar curves have been taken in many other central stations, and I would refer to a similar set of great value relating to the St. James's and Pall Mall Company's station, which are published in *The Electrician* of January 22, 1892, and which show the same general fluctuations as the Berlin curves. There are two consequences to be noted from this great irregularity in the demand. In the first place, owing to the high peak that we have during winter, we must have a large amount of machinery ready to take part in supplying current; in the summer months a great part is not in use; and during the day, even in winter, a great portion of our machinery is absolutely idle. It is in this way idle for the greater part of the year. In the second place we have to fire up our boilers during the slack hours, just before the rise, so as to be able to cope with the demand at the busiest hours, which means waste.

That being the general state of things, let us come to actual definitions about "load factors." Mr. Crompton tried to indicate that it was the ratio of the average quantity of electricity to the maximum, but what maximum was to be chosen for the whole year was not defined. I propose to adopt three distinct definitions—the machinery load factor, the current load factor, and the temporary load factor. By the machinery load factor for any period, I mean the ratio of the average current during that period to the maximum current obtainable from the machinery. By the current load factor for any period, I mean the ratio of the average current during that period to the maximum current ever supplied from the station; and by the temporary load factor for any period, I mean the ratio of the average current during that period to the maximum current supplied during that period. If we adopt these three, I think they will be sufficient for all our purposes.

Now we come to the question of high pressure supply. It was perfectly obvious, from the earliest attempts at distribution, that we should lose very considerably if we tried to extend low pressure to any great distances, and the obvious remedy for the difficulty lay in using high pressure, which involves smaller wires, at any rate. The old attempts that were made were of two kinds. The first attempt was by means of storage batteries; and in my previous Cantor Lectures I was able to give you an account of a great attempt that had been made to introduce such a system at Colchester. The scheme died from various causes, among others, that the batteries which were employed were not thoroughly reliable. An exactly similar scheme has since been worked out in Chelsea, by the engineers who superintended the Colchester system; we have there an example of storage batteries, put into sub-stations, which are charged all in series by high tension mains, and which discharge into the houses by independent low pressure mains. That system is one which we can see now, as the result of some time of working, is satisfactory in many ways, the only serious objection being probably its cost. That is the only case of that sort which has been before us, and is one which interests us very much, as being a development we would wish to see thoroughly successful. The other attempts directed towards a system of parallel-series made in previous days were all distribution, as we have called it. The lamps and mains were divided into groups, the lamps of each group being put in parallel, and the successive groups put in series—*e.g.*, it would be possible to have a dynamo working at 400 volts, with five main wires in the distribution network, the lamps being placed between the first and the second, the second and the third, and the third and the fourth. There would be thus four groups of lamps, which would be in series with each other, each group only taking its hundred volts, while the dynamo would be giving 400 volts, and we should be thus able to go four times the distance that we should with the ordinary two-wire system, or to twice the distance that we could with a three-wire system of 200 volts. This system has been adopted in several cases abroad; even at the time of my previous lectures it had been used for some time in Hungary, at Temesvar. It has been since then more extensively introduced by one or two central stations; the most notable one being the Secteur Clichy in Paris. The difficulty with this system of distribution lies in the fact that when at any time of the day the number of lamps upon the different groups is not equal, the groups which have the fewest lamps have the highest pressure working on them and the lamps are too bright, while those groups which have the greatest number of lamps have the lower pressure and are too dim. Various attempts have been made to get over this trouble. I showed you in my previous Cantor Lectures an arrangement which I myself had tried to elaborate, of

an automatic switching of the lamps from one set of mains to the other, but I think it is too complicated and not likely to succeed. Another plan occurred to me at the time, but the difficulties in the way of introducing it seemed so great that I did not mention it; this has been introduced in the Secteur Clichy, Paris. There is introduced at the different parts of the network what is called a compensator, which consists of four different dynamos all on the same shaft, and each dynamo is connected on one of the four groups. Suppose there is one circuit receiving too much pressure because there are too few lamps, then the pressure on the dynamo corresponding to that group is greater than the other four dynamos, and it will therefore act as a motor and be driven at greater speed than if it was quite out of the circuit. Being driven at greater speed, it raises the pressure in all the other different circuits, and thus in the circuits in the groups which have least pressure, the corresponding dynamos are acting as dynamos generating electricity, and in the groups where the lamps are fewest, they are acting as motors absorbing current and giving power to the dynamos. This is not satisfactory, the compensator requires to be continually at work, and the experience of the directors of the Secteur Clichy is that about twelve horse-power is being wasted in friction of the machine, and the consequence is, it is a very wasteful system to introduce. Even though the machines are extremely perfect and require very little attention, still they need lubrication; the brushes need some attention; so combining the attention required and the waste there is in the friction of the machine, the system has not been approved, and is going to be abandoned. The alternative to which they have been driven is to use batteries of accumulators to act as compensators, put in at different parts of the network of mains—a series of batteries, say 50 cells each, between each of the pairs of mains; that is to say, in parallel with each group of lamps. These batteries will maintain the pressure, and if there are too few lamps on one group, the current will pass through the battery and will be charging it up, and the battery will act as a regulator. They behave extremely well, but batteries are, of course, an expensive item. You will notice that this five-wire system—which would be more satisfactory and more economical—is very similar to Hopkinson's many wire system—an extension of his three-wire system, patented by Hopkinson and Edison simultaneously. The difference is that in Hopkinson's there is not a single dynamo of 400 volts, but four dynamos of 100 volts each, and they are put upon the separate groups. At the moment when the number of lamps on each group is the same, there will be no current passing through the intermediate wires, the four dynamos will be generating their 400 volts, and the current will be going in at one extreme wire and coming out at the other. When the lamps are used more on one group than another, then the intermediate wire will carry current, and one dynamo will be doing more work than another. I cannot conceive how they could have introduced in Paris an unnecessary difficulty by putting in one dynamo of 400 volts instead of four, which obviates very much the difficulties. Coming down to other high pressure systems, the most important, and the one which has received the most development, is the alternate current transforming system. The convenience of this is enormous; we are able to send an alternating current through an extremely fine wire to a great distance — a main one-twentieth part of the section will carry current supplying the same energy as in the low tension. Of course it is dangerous to bring the high tension into our houses; but the transformer gives us the utmost facility, by the most beautiful contrivance, of transforming down and producing low pressure. By passing the current through one set of coils in the transformer, we do, by alternately magnetising and demagnetising the core, induce in the secondary coil—totally distinct from the primary—currents which are of low tension. This is of the utmost importance, because, in a properly constructed transformer, it is possible to ensure absolute immunity from danger, and from the high pressure entering the house. I regret that that is not always done in practice; inefficient transformers have been introduced, but there is no excuse for bad work in that way. The alternating current lends itself to distribution in another way, and this is a point which has not been sufficiently attended to in the past. The method which I have suggested is about to be adopted in the lighting of the city of London, and I think, when once it has been introduced there, it will be generally adopted in other cases.

You will remember, when I was speaking about feeders and low pressure systems, I showed you that there was some difficulty in regulating the pressure in different feeders. There is not the slightest difficulty in this way with alternating currents. This

can be done simply by the introduction of what is called a choking coil—coils of wire, in the centre of which we can introduce iron wire. By this means we are able to reduce the electromotive force which is acting upon a feeder, without consuming energy, at the same time; and the distance to which we introduce the iron into the centre of the coil gives us the means by which we can regulate the E.M.F. on that feeder. We thus have the most perfect way of regulating the pressure in the different feeders. Another method is equally applicable, and that is to pass the current through a transformer in the central station, and take off the current from the whole of the secondary coil in the transformer, or rather less. We may switch on to different parts of the secondary coil, and thus, by adjustment, can take off current at 100 volts, and at different voltages. These two methods will, in the future, be of the utmost importance in electrical distribution by means of the alternating current.

The alternating current has been objected to, on a great many different occasions, by those who are either interested in supporting low tension for some reason, or who do not fully appreciate the merits and advantages of the alternating current. There have been certain disadvantages connected with it, which we must look to; and if we hope for the alternating current to survive as the best system, we shall wish to see these difficulties removed. The first important difficulty we need pay attention to is, that hitherto it has not been good for driving motors. This is not so serious a difficulty as it looks at first sight. The experience gained where motors have been put on lighting circuits has not always been favourable to that arrangement, and in many central stations it is found desirable to have separate machinery and separate distribution mains for the motor circuits. If the motors are not under the same conditions as the lights, and are doing at all heavy work, or are put suddenly on to a very large amount of work for a short time, such as lathes, &c., a strain is put on the electrical supply in the immediate neighbourhood, and the lamps in the vicinity become dim. In a motor circuit, the regulation of pressure to a very great nicety is not of such great importance, but in lighting circuits the regulation is of the utmost importance; therefore it is not desirable that they should be put on the same circuit. One of the chief reasons alleged for putting motors on the lighting circuit was that the load factor would be improved. This is not the case, however, as the two overlap at the busy time, the maximum amount of light being required at the same time that current is required for the motors. I believe that in the future developments of central station distribution by means of alternating current we shall have got over these difficulties entirely. The other difficulty which really needs to be overcome relates to electro-chemical operations; for these the alternate current is not very suitable. Of course we cannot charge storage batteries, nor can we use the alternating current for electro-deposition. But current for electro-deposition is not generally let out from a central station; if it were a good plan to do so we might see a solution to the load factor problem by letting out current at cheap rates; as a matter of fact, for electro-deposition works it is cheaper to generate electricity direct than to take it from a supply company. As to storage batteries, it is very convenient to be able to charge storage batteries, but so long as our station is so managed that we do not require any reserve power, the necessity for storage batteries diminishes; and I must say, as the result of practical experience in the past, we are improving every year in the certainty of our supply of electricity, so that at the present moment there is really only an infinitesimal number of stations being called upon to supply electricity from storage batteries, and every year is diminishing the possibility of such a thing. I must say that such a supply is an advantage not to be overlooked in a well-regulated central station.

Now, I have said there will be some considerable changes in our methods of distribution of electricity by means of the alternating current. The greatest alteration which I expect will occur lies in the fact that it will be found most satisfactory from many points of view to introduce sub-stations. Up to the present it has been the custom, when using alternating currents, to put a transformer in the house of each consumer. It is in the first place somewhat costly to make separate transformers. In this, as in all other cases, if you make up a thousand horse-power in small units you require a very great deal more material and labour than when you make up the same in larger units. It is also inconvenient to put transformers in the houses for another reason, namely, that it is very much

more difficult to regulate the pressure so as to keep it perfectly constant at all hours, because, in addition to the changes in the pressure owing to the distribution, as in the low tension distribution, we have an actual loss in the transformer, and though a great part of this loss is a perfectly constant fall of pressure, and therefore does not affect the distribution problem, still there is a certain amount which is variable with the load; therefore we are introducing by this system an extra difficulty in regulating pressure. If we introduce sub-stations from whence the low tension is distributed, the pressure regulation can be done by attendants, provided always that we make them sufficiently large to make it worth while to employ attendants. There seems not the slightest doubt that we shall be able to adjust this in another manner, by making the transformers self-regulating to a certain degree, so that it will be possible to place these large sub-station transformers in underground vaults, say, in places where they only require very occasional inspection, and where they do not require to have continual attendance. There are several inventions which have been made in this direction, and I had hoped to show you some which have been introduced by Mr. Ferranti; and he himself would have been most willing, but unfortunately, as you know, there are some troubles connected with foreign patents, and the possibility of too much being divulged prevents me from showing this apparatus. You can perfectly easily see that it is possible to arrange some sort of automatic switch, so that when the demand for current increases, an additional transformer will be switched into the circuit, and when the current falls off, this switch will act in the opposite direction and put in a smaller transformer. It is also possible to wind our transformers, both primary and secondary, with more than one wire, and to have an automatic arrangement by which these coils shall be put in series or parallel, primary and secondary simultaneously, according to the different demands for current; that also will get over our difficulty. The effect of such changes will be to make the transformers work at their economical load. There is always a loss in a transformer due to hysteresis, and that loss is pretty constant whatever the demand for current may be. Now, by proportioning the size of our transformer to the load required, we are able to make the hysteresis loss a small proportion of the total current required to keep the transformer working at its efficient load.

At the present time, with a transformer in every house, transformers are working in a very inefficient manner during the greater part of the time, both when the load is light, and during the daytime, when no secondary current is being taken at all. These transformers must always be supplied with current, and even during the daytime consume an appreciable amount of energy—that used in overcoming the hysteresis of all the transformers over the whole town. But with our sub-stations supplying secondary low tension to the mains, we shall have only a very small number of transformers at work during the hours of light load; and the consequence will be, that each transformer will be working in an efficient manner during the whole 24 hours. I think we may safely look for an average efficiency of 90 per cent. during the whole of the 24 hours. I may say the feeling at the present time is very general among engineers that sub-stations ought to be introduced, instead of having transformers in every house.

If we are to introduce these sub-stations, it becomes necessary to review the whole system of distribution, and consider whether we are working in the right direction. There is one point requiring radical modification, *i.e.*, the frequency of alternations used in connection with our distribution. When the pioneers in this line started work it was of course looked upon as a great feat to get nearly the whole of the energy transformed and supplied in the secondary circuit; and it was a great feat to do this by means of cheap apparatus. It was impossible to do this cheaply and economically, unless we used very small transformers; and the only way in which we could use very small transformers, with high pressures of 1,000 volts, was by having rapid alternations, and consequently the pioneers used dynamos which gave very rapid alternations and a very small transformer. The result is, that you get a very considerable consumption of energy due to the hysteresis of this transformer.

Now when we come to use sub-stations with very large machinery, the economy which is to be gained by using high frequency is not nearly so large, not nearly so well worth considering, as it is when we are dealing with scattered lighting, and able to put transformers more economically in every house. For this reason then, I think it would be desirable to reduce the frequency of our alter-

nations as low as the frequency of the alternations in an ordinary continuous current dynamo armature. That is to say, reduce from 130 and 80 periods per second down to something like 5 or 10 periods per second. There are other reasons why we should use low frequencies. When we have secondary mains of that large section of copper used in our low pressure systems, it is only with difficulty that we can force a current of high frequency through it. High frequency has a remarkable effect on the conducting qualities of large conductors. The whole of the current is forced towards the outside of the conductor and makes the inside of the conductor almost useless as a means of carrying the current. It is only by diminishing the frequency of our alternations that we shall be able to get over this very serious trouble, which will attack us as soon as we have low tension mains carrying alternate currents. There is another advantage in using low frequency currents, and that is, the problem of electro-motors is immediately solved. It has been a wonder to many why we could not use continuous current motors with the alternating current, if the field magnets were made of laminated iron. It was said that a current in the one direction drives the motor in the one way, and if we reverse the direction of the current, it still goes on in the same way. Why should not this happen with an alternating current? So it would, but the employment of an alternating current to magnetise the field magnets of these motors involves an enormous counter E.M.F. set up in the coils round the field magnets, as the effect of what is known as self-induction; the consequence is that a great proportion of the volts which we supply to the motor is taken up in magnetising the field magnets. I have calculated out the particular case of a 10 horse-power motor working at 100 volts, and I find that though the field magnets be laminated in the best possible way, this motor, when worked by an alternating current, would require 99 volts in addition to the 100 volts actually needed when worked with a continuous current—practically 100 extra for exciting the field magnets. When that motor is used with a continuous current, only $\frac{3}{4}$ volt is required for magnetising the field magnets, so that you would have to work at 200 volts to supply the motor with an effective E.M.F. of 100 volts, and yet at the present moment motors of that character are being used largely in America on lighting circuits, for some purposes where the power used is small, so that an output of 30 or 40 per cent. of what might otherwise be obtained is ample for the purpose. I have calculated that if you were to reduce the frequency to five periods per second, the volts required in that case for exciting the field magnets would be 6 instead of $\frac{3}{4}$ volt. We should thus be diminishing the output of the motor down to 90 per cent., which is not a serious thing, and be making the use of such a kind of motor practicable. We know perfectly well that alternating current motors are being developed by other means, and that some of them are far superior in practical working to any of the continuous current motors; and, consequently, the direction in which this part of the subject will be extended is almost certainly in the development of these new types of motors, which have attracted so much attention elsewhere. Even for that class of motor too, there is no advantage in having high frequency, and it will be a distinct gain to have low frequency. Low frequency will also enable us to introduce a commutator in such a way as to convert alternating current into continuous, and that will enable us to charge storage batteries. At the present time the only way of doing this with alternating current is to employ an alternating current motor, and cause it to drive a continuous current dynamo machine. By that means we are able to charge storage batteries; but by introducing low frequency the advantages are so great that I think it is most desirable, when we are considering the question of using substations with large transformers supplying the secondary mains, that we should also consider the other alternative of using low frequency, and a commutator to convert the alternating into a continuous current. The only reason why we use high frequency is the large number of transformers; it economises their construction, and we are able to have a cheaper transformer; but you will see that that *desideratum* is diminished when we come to the sub-station method of distribution.

Other systems of establishing high tension have been proposed, the most important that has received attention being the continuous current transforming system, which consists in sending high tension continuous current from a central station to a distant substation, where the current is received and passed through a motor, which serves then to drive a continuous current dynamo of low pressure. That dynamo then serves as a source of energy to the neighbourhood around, supplying the mains in its immediate neigh-

bourhood. We can have several of these sub-stations, so that from one central station we are able to distribute our power in the form of high-pressure electricity to several distant points, and then to produce low-pressure electricity and distribute through our mains. These combination machines, of motor and dynamo combined, can be made of a very high degree of efficiency owing to a remarkable fact. The efficiency of a dynamo or motor is impaired by the reactions produced by the currents in the armature, and these reactions, in the case of dynamo and motor, are in opposite directions. If now we wind a high tension winding on an armature to serve as that of a motor, and on the same armature we wind a low tension winding which is to act as that of the generator for the low-pressure supply, and put a separate commutator and a separate pair of brushes to each of these windings, we have the same machine acting as a motor and as a dynamo, and we have an absence of those armature reactions which would be produced either by the motor winding or by the dynamo winding alone, because they are produced in opposite directions by the two windings when we use one as a motor and the other as a dynamo, consequently we have an apparatus which is extremely efficient and useful.

We must consider the fact that, in working this way, we are conveying our power from our central station to the sub-stations by means of high-pressure electricity; and we are committing ourselves to the statement that high-pressure electricity is the most economical means by which we can transmit power from one place to another. There are several ways in which we can carry power from a central station to different parts of a town. We can do it by passing air compressed at a central station through pipes to the different sub-stations, there using it in engines, which may be ordinary steam-engines, to drive our dynamos. Or, we may do it by means of water which is kept under pressure by pumping it into hydraulic accumulators at a central station. From this central station the high-pressure water may similarly be led through mains in the town, and be utilised in water motors for driving the electrical machinery at the sub-stations. These are two ways, besides the electrical way, in which power may be given to the sub-stations from the central source, and we have to consider which of these three is the most economical. The compressed-air method is being largely used at Birmingham; it is also being used for electric lighting in Paris on the Popp system. I do not say that at the present moment the results have been altogether economical, but I do say that the system of transmitting our power to sub-stations by compressed air deserves far more serious attention than has been generally accorded to it. I have heard people who were in ignorance of the methods which can be used for supplying compressed air, or who have only had experience with very defective apparatus for this purpose, speak of the mere 20 or 30 per cent. efficiency obtainable; this is utterly erroneous. The efficiency you can get is very good indeed, and the difficulty lies not so much in that as in the large space taken up in the streets by the pipes to carry the compressed air. The same remarks apply to water-power. High-pressure water is now being distributed through London from the large central stations of the Hydraulic Power Company. That water is used chiefly for working lifts or elevators; it may be used for other purposes. Here, also, the economy is good. Here, again, the difficulty is a 6-inch main which is being used. The total power which can be supplied through such a size of main at the pressure of 700 lbs. is something like 100 horse-power. So that, when we come to transmit large powers, the space which would be occupied by the mains would be too large to allow of the system being really practicable in most cases. There might be cases in outlying towns—in parts of London even—where the roadway is not filled up with pipes, where it might be desirable to introduce compressed air or hydraulic power. But probably these cases are very few; and certainly in busy parts, like the city of London, or the greater number of the streets in London, it would be too expensive to proceed in this way. So that, in all probability, the high-pressure electrical system is the best for supplying sub-stations; but I beg electrical engineers not to cast aside, as utterly useless, the other means of supplying power from central stations, which may, in some cases, be useful. There is still another way, and that is by the distribution of gas: either the ordinary illuminating gas, or gas specially prepared for heating purposes. Of the latter kind, the best known is the Dowson gas, which can be produced extremely economically—at about 10d. per 1,000 feet. The question is, simply, Is it ever economical to introduce gas-engines in sub-stations, instead of generating power by steam-engines? I have no hesitation in saying that it is in very many cases economical. Gas-engines have increased in use in the last few

years; the sizes of gas-engines have also been increased. Hitherto gas-engines have not been made very large, solely because the purposes for which they have been required have generally been those requiring small amounts of power; and people have been doubtful of their applicability to purposes requiring large power. The largest gas-engines indicate 170 horse-power with ordinary gas, or about 160 with Dowson gas. Such gas-engines are in use in London, and can be seen at work at any time; there are also 98 horse-power engines working at Portsmouth for generating electricity. The floor space taken up is 14 square feet, therefore the space is not large compared with steam. It would be perfectly easy to make larger ones if they were wanted, but I believe that, for such sub-stations as those in which they would be likely to be used, 170 horse-power is as large a size as it would be desirable to introduce; and we should, therefore, be simply using gas-engines on the market at the present moment. It is asserted that only 16 cubic feet of gas per horse-power hour indicated is used, and, therefore, even allowing a slight margin for the sanguineness of the manufacturers, we should reduce the cost of power to a very moderate figure, especially in places where gas is very cheap. When we look at this question of using gas-engines in its bearing on the load curves I have been speaking of, you will see the enormous gain gas-engines could effect. With gas-engines, you do not require to be firing up boilers long beforehand for a few hours' work; your gas is always ready, and you can start at the time you have to supply power, without having gone to any waste beforehand in getting your plant into working order, as with steam plant. A large proportion of the 9 or 10 or 15 pounds of coal to the electrical unit needed with steam plant is consumed in heating up the boilers preparatory to starting work; and this means considerable expense, which would not be incurred if gas-engines were used. I am sure the question will attract the attention of engineers, and that in designing central stations in future, this plan will not be lost sight of.

I will now conclude with referring shortly to some of the systems adopted for laying conductors underground, and will describe to you an ingenious automatic safety device of Mr. Ferranti's, which is appropriate to this lecture. I need hardly take up time with describing different kinds of cable used. We have cables insulated with vulcanised india-rubber, okonite, various bituminous compounds, and air. Some people have used lead-covered cables, while in other cases the conductors are left bare. I pointed out, a few years ago, some serious defects which had occurred in the lead-covered cables employed in Berlin and Rome, due to faults in the manufacture, and want of care in laying. Great improvements have, however, been made since then. I also described, at the meeting of the British Association in Manchester, in 1887, a system of mains which is exceedingly simple. I use cast-iron pipes, and run bare copper tubes through them. The copper tubes, which are supported on porcelain insulators (Fig. 1, p. 881), may be first used as the conductors alone, and when the demand increases, bare wires can be drawn through the tubes. In the figure, which is more or less diagrammatic, the method of making a house connection is shown, iron tubes being tapped into the side of the pipe, through which the house mains are led and soldered to the outside of the copper tubes only, the inner wire-conductors being left untouched.

Fig. 2 (p. 881) shows a Crompton conduit formed of concrete, in which bare copper mains rest on glass insulators supported on oak bars. At the extreme left is shown the arrangement by which the copper strips are kept from sagging down between the insulators. The copper strips are passed through the bridge piece, which is insulated from the cross-bars by glass insulators also, and when pulled taut are nipped by the set-screws, one of which is shown in the sketch, and thereby kept in position.

In Fig. 3 (p. 882) is shown a section of the conduit used by the St. James's and Pall-mall Company. This consists of a cast-iron trough with cover, the two being joined by a red-lead joint, and bolted together. Bare copper strips are supported edgeways on porcelain insulators, bridging over the bottom of the conduit to allow of free drainage, and are held in place with wooden wedges; between the insulators porcelain distance pieces rest on the copper strips to keep them apart, as shown in the figure.

One of the well-known Callender bitumen concrete casings is represented in Fig. 4 (p. 882), through which insulated cables are drawn. An objection to this conduit is its perviousness to water. In tests that I have made, a block with four ducts, weighing 20 lbs. 8 oz., absorbed 4 oz. of water during an immersion of 46 hours. Another piece, with two ducts, weighing 6 lbs.

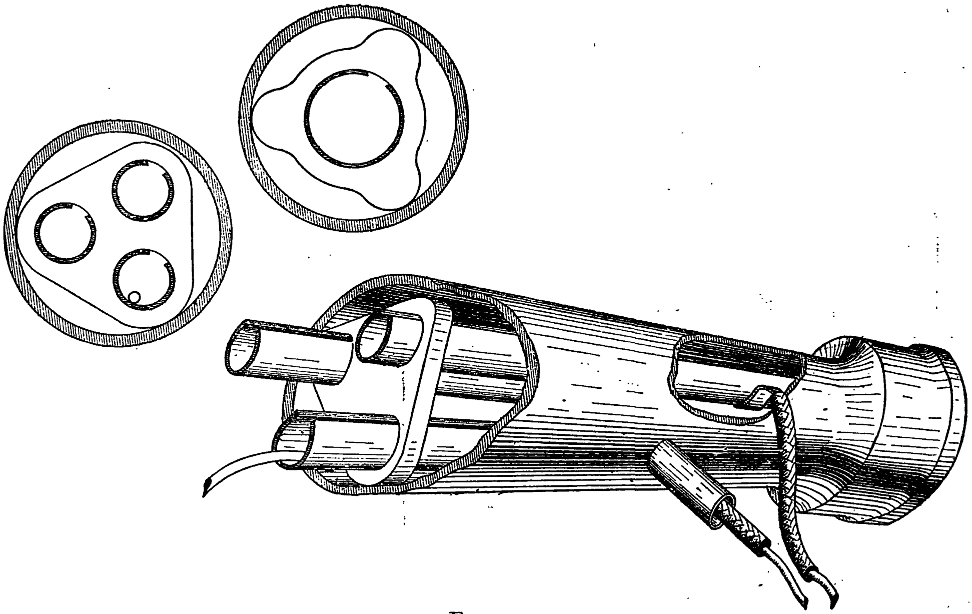

FIG. 1.

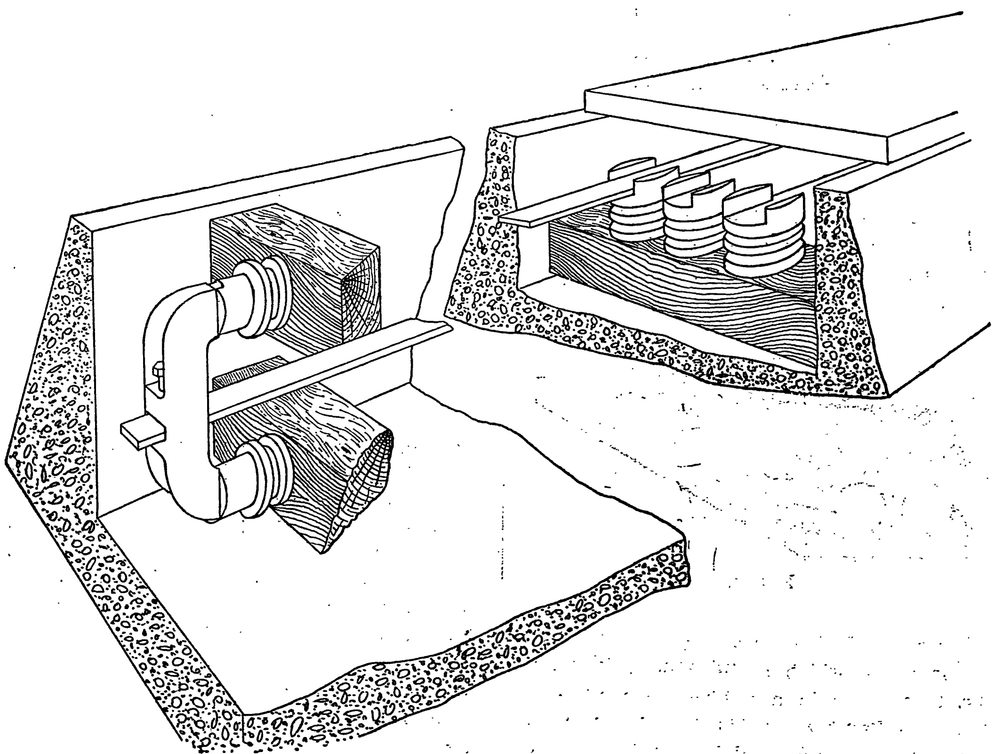

FIG. 2.

13 oz., absorbed 1 oz. in 46 hours, the water being put in the ducts, which were plugged up at one end. In this latter piece a pin-hole was found leading from one of the ducts to the outside, through which the water leaked.

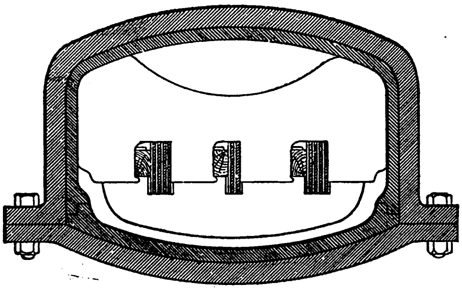

FIG. 3.

Lastly, in Fig. 5, we have the Macdonald conduit. This is made of creosoted wood, and consists of three or more pieces, joined by tongues running the whole length of the conduit. The labour of laying this conduit is

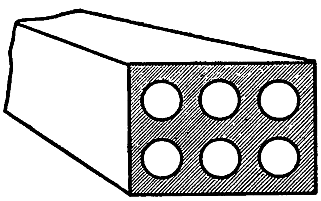

FIG. 4.

small, and the number of ducts can be increased by merely adding centre pieces, the pieces being laid so as to overlap at their ends as shown, thereby forming a compact whole.

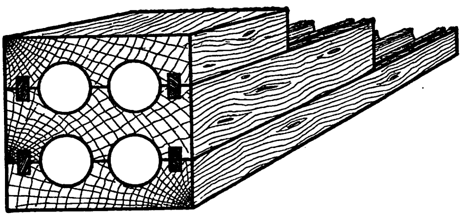

FIG. 5.

The safety device for alternating circuits I mentioned, of which a diagram is shown in Fig. 6, consists in a means for cutting off the supply to a house when there is a leakage on any circuit, or a breakdown of the insulation of the house transformer. A and B are the primary circuits, and C, D the secondary, of two small but similar transformers, the primaries being in series and placed as a shunt across the house mains, the secondaries also being in series but forming part of a distinct circuit, in which is included a fuse as shown, on which is suspended a plug which, if allowed to fall, short-circuits the house mains between the points F and G. The primaries and secondaries of the two small transformers are connected up so that the E.M.F.'s of the latter oppose each other, and, being equal

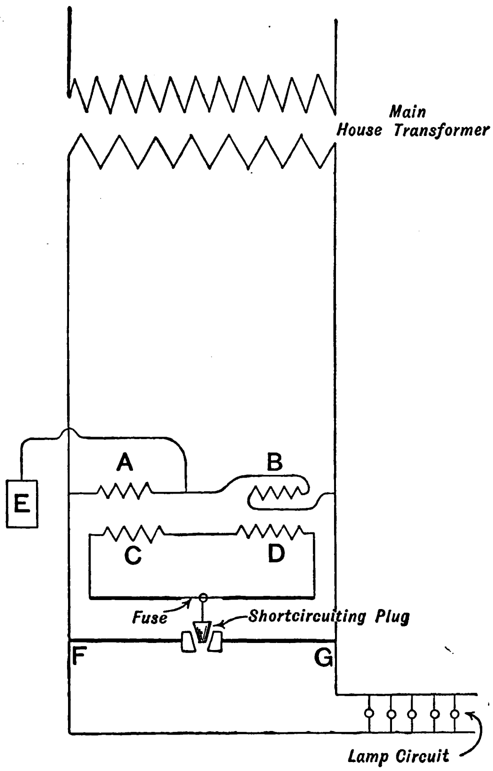

FIG. 6.

in magnitude in the normal state of working, consequently produce no current in the fuse circuit. The junction of the primaries is at all times connected to earth. Now, suppose a leakage occurs on the lower wire of the lamp circuit. This will upset the balance of the two transformers, by reducing the current passing through A, consequently the E.M.F.'s in the secondary circuits of the transformers will not now be equal, but that in D will overcome that in C, and a current will pass through the fuse and blow it out, allowing the plug to fall and short-circuit the house mains, the

result being that the main fuse (not shown) will be blown out and the supply to the house be cut off. The same thing will result if the pressure rises at either terminal of the secondary of the main transformer, owing, say, to a leakage from the primary to the secondary. In the actual apparatus there is a third block, connected to earth, that the short-circuiting plug makes contact with when it falls, thereby putting the house circuits to earth effectually, and minimising all risk from shocks.

Miscellaneous.

THE CHICAGO EXHIBITION.

Reuter's agent at Chicago sent the following information to the papers this week about the recent appropriation voted by Congress for the purpose of the Exhibition:—

Although the appropriation made by Congress for the World's Fair was reduced during the debate in the House of Representatives from £1,000,000 sterling (5,000,000 dols.), to £500,000 (2,500,000 dols.), the result will, it is believed, be extremely satisfactory to the managers of the Exhibition. The money was granted in the form of 5,000,000 special souvenir silver coins, of the weight, fineness, and value of the regular silver half dollars in current use. As soon as it became known that the souvenir coins were to be issued to the Fair officials from the United States Mint at Philadelphia, there was an immediate demand for them from all parts of the country.

It at once became apparent that the coins could be disposed of by the Exposition at a large premium. The editor of a leading New York newspaper offered 100 per cent. premium for 10,000 coins; merchants and bankers made similar offers, and during the five days succeeding the passing of the Bill, tenders were received for 600,000 of the coins at 100 per cent. premium. A syndicate of bankers in the West offered to take the entire issue at 60 per cent. Fabulous offers have also been made for the first souvenir coin struck at the Mint. A Chicago newspaper started the bidding at £25, but several wealthy men in Chicago have expressed their intention of securing this coin if it costs £200. It is probable that the coin will be sold at public auction in Chicago, a certificate from the Director of the Mint going with it to guarantee that it is the only genuine first souvenir coin. It is probable that all the coins will be sold by the World's Fair Management at 100 per cent. premium, and that the Exposition will be enriched to the extent of £1,000,000 by the national appropriation.

*THE UTILISATION OF NIAGARA.**

Few persons can have seen Niagara Falls without reflecting on the enormous energy which is there continuously expended, and for any useful purpose wasted. The exceptional constancy of the volume of flow, the invariability of the levels, the depth of the plunge over the escarpment, the solid character of the rocks, all mark out Niagara as an ideally perfect water-power station, while, on the other hand, the remarkable facilities of transport, both by steam navigation on the lakes and by four systems of railway, afford commercial advantages of the highest importance. From a catchment basin of 240,000 square miles, an area greater than that of France, a volume of water amounting to 265,000 cubic feet per second descends from Lake Erie to Lake Ontario, a vertical distance of 326 feet, in 37½ miles.

Supposing the whole stream could be utilised, it would supply 7,000,000 horse-power. This is more than double the total steam and water power at present employed in manufacturing industry in the United States.

Immediately below the Falls the river bends at right angles, and flows through a narrow gorge. The town of Niagara Falls on the American side occupies the table-land in this angle.

The earliest traders who settled near the Falls erected stream mills in the Upper River in 1725, for preparing timber. Later, the Porter family erected factories on the islands in the rapids above the Falls. It was not, however, till about thirty years ago that any systematic attempt was made to utilise part of the water-power of the Falls. Then a canal was constructed from Fort Day, about three-quarters of a mile above the Falls, to a forebay or head-race along the cliff overlooking the lower river. In 1874 the Cataract Mill was established, taking power from this canal, and other mills were gradually erected till about 6,000 horse-power was utilised. These mills have been exceedingly prosperous, but since the growth of a feeling against the disfigurement of the Falls, it has become impossible to extend works of the same kind.

The idea of a method of utilising the Falls, capable of greater development, and free from the objections to the hydraulic canal with mills discharging tail water on the face of the cliff, is due to the late Mr. Thomas Evershed, Division Engineer of the New York State Canals. He proposed to construct head-race canals on unoccupied land some two miles above the Falls. From these the water was to fall through vertical turbine pits into tail-race tunnels, converging into a great main tunnel, discharging into the lower river. Apart from an inappreciable diminution of the volume of flow over the Falls, this plan avoids any disfigurement of the scenery near the

* Extracted from the opening address of the President Professor W. Cawthorne Unwin, F.R.S., to the Mechanical Science Section of the British Association.

Falls, and permits a head of nearly 200 feet to be made available. It is, however, essential to such a plan that work should be undertaken on a very large scale. In 1886, the Niagara Falls Company was incorporated, and obtained options over a considerable area of land, extending from Port Day for two miles along the Niagara River. In 1889, the Cataract Construction Company was formed to mature and carry out the constructional works required.

The present plans contemplate the utilisation of 100,000 effective horse-power. The principal work of construction is a great tunnel 7,250 feet long, which is to form a tail-race to the turbines, starting from land belonging to the company and discharging into the lower river. The tunnel is 19 feet by 21 feet, or 386 square feet in area, inside a brickwork lining 16 inches thick.

The base of the tunnel is 205 feet below the sill of the head gate, and permits a fall of 140 to be rendered available at the turbines. The brickwork of the tunnel is lined for 200 feet from the mouth with cast-iron plates.

The tunnel has been excavated with remarkable rapidity with the aid of drills worked by compressed air.

The main head-race, about 200 feet wide, will run for about 5,000 feet parallel with the river, having entrances from the river at both ends. Near the lower reach the Soo Paper Company is already arranging to utilise 6,000 horse-power, discharging the water from the turbines through a lateral tunnel into the main tunnel. Near this lower reach will also be placed two principal power stations, from which will be distributed, either electrically or otherwise in ways not yet fully determined. The first turbines to be erected in these power stations will be twin turbines of the outward flow type of 5,000 effective horse-power. These turbines have a vertical shaft for driving dynamos or other machinery placed above ground.

According to Mr. Evershed's original plans, it was intended to distribute water by surface canals to different power users, each of whom would sink his own turbine pits, connected below by lateral tunnels to the main discharge tunnel. Some of the power at Niagara will undoubtedly be used in this way, and in the case of industries requiring a large amount of power, it will be economical to purchase a site and water rights.

Such a plan is, however, not adapted to smaller factories. Obviously for them it would be more economical to develop the power in one or more central stations by turbines of large size under common management. Further, once given the means of distributing power instead of water, an important extension of the project becomes possible.

Besides supplying power to industries which may locate themselves at Niagara, the power may be transmitted to the existing factories in Buffalo and Tonawanda.

Arrangements are already proceeding to transmit 3,000 horse-power to Buffalo, a distance of 18 miles, to work an electric lighting station.

In 1890, Mr. Adams, the President of the Niagara Construction Company, visited Europe to examine systems of power distribution. It was in consequence of this visit that the important modifications of the plans of the company involved in the substitution, to a large extent, of a system of power distribution for a system of water distribution came to be adopted. The American engineers were anxious to obtain the best European advice as to the methods best suited to the local conditions. A commission was formed, consisting of Lord Kelvin, Dr. Coleman Sellers, Professor Mascart, and Colonel Turrettini, and an invitation was given to engineers and engineering firms in Europe and America to send in competitive projects for the utilisation of the power at Niagara and its distribution to different consumers at Niagara and in Buffalo by electrical or other means. Many of the plans sent in were worked out with great care and completeness. As to the hydraulic parts of the projects, there was some approach to general consent as to the arrangements to be adopted, but as to the methods of distributing the power there was an extraordinary diversity.

Generally the Commission reported in favour of electrical distribution, with perhaps a partial use of compressed air as an auxiliary method.

Generally also they reported in favour of methods of distribution by continuous currents in preference to alternating currents. Since the date at which the Commission reported, the Frankfort-Lauffen experiment has been made, and in the opinion of some electrical engineers a distinct advance has been achieved in the use of alternating currents at high potential.

The company has not yet decided to adopt any plan for the central stations except in a tentative way. One or more turbines of 5,000 horse-power are to be erected, and probably at first this power will be distributed to Buffalo by an alternating current system.

The cost of a steam horse-power at Buffalo is reckoned at $35 per annum. I believe the company will be able to deliver power at from $10 for large amounts and a greater price for small amounts, this price being reckoned for twenty-four hour days.

The new industry of electric lighting has made necessary the provision of large amounts of motive power. Electric traction similarly depends on the supply of motive power. New chemical and metallurgical processes are being introduced which entirely depend for their commercial success on the supply of motive power at a low price.

Niagara is likely to become not only a seat of large manufacturing operations of familiar types, but also the home of important new industries.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, SEPTEMBER 2, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, August 30th. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Alfred Carpmael, Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S, Walter H. Harris, Charles Malcolm Kennedy, C.B., John Biddulph Martin, John O'Connor, with Sir Henry Trueman Wood, Secretary.

FOREIGN LABOUR.

The following joint resolution has passed the Senate and the House of Representatives of the United States. Its object is to authorise foreign exhibitors at the World's Columbian Exposition to bring in foreign labourers from their respective countries for the purpose of preparing and making their exhibits:—

"[Public Resolution—No. 30.]

"Whereas, under and in pursuance of the Act approved April 25th, anno Domini, 1890, the President of the United States has invited the Governments and citizens of foreign nations to participate in the International Exhibition authorised by the Act above recited; and

"Whereas the invitations so extended have been accepted by the several nations, and space for installing foreign exhibits has been applied for and duly apportioned, and concessions and privileges granted by the Exposition management to the citizens and subjects of foreign nations; and

"Whereas, for the purpose of securing the production upon the Exposition grounds of scenes illustrative of the architecture, dress, habits and modes of life, occupation, industries, means of locomotion and transportation, amusements, entertainments, and so forth, of the natives of foreign countries, it has been necessary for the World's Columbian Exposition to grant concessions and privileges to certain firms and corporations conceding the right to make such productions: Therefore,

"*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Act of Congress, approved February 26th, 1885, prohibiting the importation of foreigners under contract to perform labour, and the Acts of Congress prohibiting the coming of Chinese persons into the United States, and the Acts amendatory of these Acts, shall not be so construed, nor shall anything therein operate to prevent, hinder, or in anywise restrict any foreign exhibitor, representative, or citizen of a foreign nation, or the holder who is a citizen of a foreign nation, of any concession or privilege from the World's Columbian Exposition, from bringing into the United States, under contract, such mechanics, artisans, agents, or other *employés*, natives of their respective foreign countries, as they, or any of them, may deem necessary for the purpose of making preparation for installing or conducting any business authorised or permitted under, or by virtue of or pertaining to, any concession or privilege which may have been granted by the World's Columbian Exposition in connection with such Exposition: *Provided, however,* That no alien shall by virtue of this Act enter the United States under contract to perform labour except by express permission, naming such alien, of the Secretary of the Treasury; and any such alien who may remain in the United States for more than one year after the close of said Exposition shall thereafter be subject to all the processes and penalties applicable to aliens coming in violation of the alien contract labour laws aforesaid. —Approved, August 5th, 1892."

Proceedings of the Society.

CANTOR LECTURES.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

By Prof. George Forbes, F.R.S.

Lecture III.—Delivered February 8, 1892.

It is almost impossible for any person at the present moment to give a lecture of any description dealing with electricity without making some allusion to the remarkable lectures that we have heard in the course of last week by Mr. Tesla; and the great bearing which those lectures have upon certain parts

of the subject upon which I am lecturing, leads one naturally to say a few words about the remarkable experiments and conclusions that have been before us. I saw in one of the technical journals, this last week, a remark that after the brilliant lecture of Wednesday evening the practical man would ask, "What is this to lead to?" Well, if the man who is in the habit of calling himself the "practical" man were to ask my advice, I should advise him to leave the experiments of Mr. Tesla quite alone. That man is hardly in the position of being able to appreciate, at their right value, the experiments which we saw. I trust that the time is passing by when those who have been in the habit of arrogating to themselves the title of "practical men" will continue to do so. Those men who apply that term to themselves do not realise the self-sufficiency which is shown by their assuming such a title. It is the highest praise which can be given to the greatest engineers to say that they are practical men. The man who assumes to himself the title "practical man" is generally the man who can use his hands but cannot use his head—the man who cannot apply theory or interpret a formula—the man who could attend to a well-known type of engine, but who would be incapable of appreciating what an enormous amount has been done in the ten years that such a thing as a Parsons' steam turbine has existed. Our great men do not speak of themselves in this boastful manner as being either practical men or geniuses. Our Watts, our Stevensons, our Rennies, our Bakers, do not boast that they are practical men. They are prepared to become so, but they would not make this boast. The man who largely assumes that title, then, I do not think will be able to appreciate the value of Mr. Tesla's work. But to engineers and natural philosophers it is full of importance. Engineers and natural philosophers both look to this work as telling them a deal which has been puzzling them in the past, and as holding out great hopes for the future. There is a great difference between the natural philosopher and the engineer. The natural philosopher claims only to be Nature's pupil. The engineer aims at being her master. In Mr. Tesla's experiments the engineer sees great difficulties which have been in his way completely explained and partially removed. He sees what has been troubling him with the use of alternating currents in mains, and how the current was being allowed to leak, and he sees how to remedy that defect. He sees things that have been puzzling him in the action of air condensers, by which the apparent capacity of the condenser is enormously greater than it ought to be if there were not going on that peculiar action of bombardment of the molecules, of which Mr. Tesla has spoken so much. The engineer also sees that Mr. Tesla has worked out a system of practical electric lighting producing a most pleasing light—more so than any which we have seen before, and by a means which is almost in a practical shape. The natural philosopher, on the other hand, sees explanations of a vast number of the experiments which have been puzzling him in the past, and sees new developments, new experimental investigations, which will lead to a better knowledge of the ultimate structure of matter. Mr. Tesla triumphs to-day as the natural philosopher. To-morrow he will triumph as the engineer.

The remarks which I have made upon this subject will lead you to see that I place very great importance on what Mr. Tesla has said about the construction of mains. We have long noticed that when an alternate current of high potential and frequency is passing through a wire, there is, in the dark, seen to be a light given off from the wire, especially near a telegraph post on which that wire is supported. This was particularly noticeable in the case of the experiments conducted at Frankfort in this last year, when a large amount of power was transmitted from a distance of 112 miles by a very high-tension alternating current. We were at a loss to completely understand what was the action which was going on there and how to overcome it. Mr. Tesla has given us the answer to both; but by going to these very high frequencies and very high voltages he has exaggerated all our difficulties, and thereby been able to see the meaning of them, and to give us the cure for them with the more moderate pressures and frequencies that we use in actual practice. And there is little doubt that he has given us the right explanation of the enormous value of oil as an insulator in all these cases. There cannot be too strongly impressed upon engineers the importance of oil insulation for cables which are carrying high-tension alternating currents over long distances. Those sub-station transformers which I was speaking about in my last lecture ought, in the future, to be altogether filled with oil. We had known the value of oil as an insulator before, but we had never realised the enormous importance of it; and now that we do realise the reason

why it is so important, it will be very much more largely used.

There are some other mains which I do not speak much about because they are so generally known. The Siemens concentric mains, of which I have specimens on the table, are extremely valuable for long feeders; but for distributing mains in the town, they have the serious disadvantage that a special kind of metal box has to be used to form a junction, when taking in the leads into any house that has a light. And the cost of this is so considerable, in order to make the joint perfect, that it seriously interferes with the economy of the mains. But, for feeders, these concentric mains are admirable. Also the fluid insulators which were introduced by Mr. Brooks—and which will be largely used, I trust, in the immediate future—are extremely valuable for the same purpose for alternating currents.

For the low-tension distributing mains, I draw attention once more to the type, of which I have a diagram here (see Fig. 1, Lecture II.), which I feel convinced is the most practical type which can be used for low-tension mains. The enormous value of this type of mains lies in this, that we can lay our mains over the whole district which is to be supplied at a very cheap rate at first, when the demand is small, and we are continually able to add to the size of the mains without the slightest difficulty. Then the whole thing is cheap to construct, and the attachments to houses are perfectly independent of the naked cables—the bare wire cables—which we draw through the copper tubes, and which we change for bigger ones, when the demand in the district increases.

I come now to the question of power as apart from light, and there are two totally distinct questions in connection with power furnished by electricity, the one referring to the *distribution* and the other to the *transmission* of the power, which are often intermingled. The engineer has to consider the two together very often, but they very often are completely separate and have different demands, and may necessitate the employment of different apparatus.

Let me just give an example or two to show how very greatly different is the case under different circumstances.

A great deal has been talked in the last few years about the employment of the Falls of Niagara for supplying power to a distance, it may be. It was originally suggested by Sir William Siemens and Sir William Thomson to carry the power from Niagara into New York; and later, more practical problems have been presented for carrying that power to Buffalo, a distance of thirty miles, and a manufacturing centre. In either of these cases the great problem is the transmission of the power. To distribute it through the town is not of such enormous importance. The best means which can be devised to carry the power from Niagara to Buffalo, and change it into power there, even though it be in the outskirts of the town, is the solution of a very great problem. But, on the other hand, take the case of a power-station situated in London—let us say in Clerkenwell, where there are an enormous number of small factories or small workshops which require power. They have steam-engines at the present moment doing a great deal of that work. Those steam-engines take up room which is valuable, and they are in the way, and so are the boilers. Again, these small engines are not economical. The consumption of coal is enormous compared with the power given off; and the demand for extra attendants for looking after the boiler and engines is a serious drawback in these small workshops. There could be no place more suitable for putting down a power-station than Clerkenwell, but there the demand is totally different to the above case. It is not simply a question of generating power in one station, and then supplying it continuously to the motors in the houses and keeping the motors always going. These motors in the workshops require to be stopped and started at frequent intervals; whereas in the transmission question we do not require to be always stopping the motors. We can be running them steadily all the time. This introduces a very great difficulty, because many motors which are most available to us are incapable of starting freely every few minutes, as when we require to start working a lathe or anything of that sort, and therefore for the distribution of power we must have special kinds of motors which are capable of starting frequently with the utmost ease.

Of course when we are transmitting power to a great distance it is perfectly obvious that we shall be obliged to use high pressures. If we do not use high pressures we shall be obliged to use large conductors, in order that we should not waste much energy on the road; and consequently, whatever system we are going to use—whether we are using continuous currents or whether we are using alternating currents—we must be dealing with high pressures. Every

special case needs to be calculated out on its merits as to the pressure which will be required and the size of the wires which we shall have to use, because we never wish to use a higher pressure than is absolutely necessary. It is always a disadvantage. The difficulties and dangers are always increased when we go to higher pressures; we want to use as low a pressure as is feasible, and will make the thing a commercial success.

As you are all aware, Sir William Thomson, in 1881, laid down a general rule for the economy of conductors. Summarised in the simplest form, it amounts to this, that the interest on the capital invested in copper shall be equal to the cost of the energy which is being wasted in the mains. Some years ago, Professor Ayrton read a paper before the Institution of Electrical Engineers, in which he considered that Sir William Thomson had made a mistake in this law, when it was applied to such a case as that of the carrying of power from Niagara to New York; and he argued that this law did not hold. But, as a matter of fact, the whole of the mathematics by which he supported this argument simply resolved themselves into this, that the cost of the energy which you have to take into account is really partially dependent upon the amount of copper that you have put down; that is to say, the farther the distance off from your generating station, the greater is the cost of the copper, and therefore the greater is the cost of the energy; so that, when you go to far distances, you have to allow for a greater cost per horse-power hour than you would have done if you were not going to so great a distance. This is the whole secret of the merits of the case—as I may almost call it—but Professor Ayrton thought that he had found a flaw in Sir William Thomson's argument.

I pointed this out to a gentleman who gave some lectures on the transmission of power in this hall not long ago, and he slightly misunderstood the explanation which I have just given you, and said that we had to consider as the cost of the energy the cost which that amount of energy would fetch in the market; and that, since the energy was more valuable at New York than it was at Niagara, therefore we had to add to the cost of the energy when we were transmitting it to New York. It is not so. It is simply that the cost of the energy is increased by the fact of carrying it to that distance through the copper conductors.

Now, as a matter of fact, in all these cases which come before the engineer of the transmission of power to a distance, the only really satisfactory way of applying the principle of Sir William Thomson's law is to work out the results at several different densities of current; and this involves a very considerable amount of work. You must take approximate figures in the first place, and assume different pressures of the electric current—1,000 volts, 5,000 volts, 10,000 volts, and so on—and work out the cost of sending your power at all these different pressures, and also at different densities of current in your conductor, *i.e.*, with the conductor carrying different strengths of current per square inch of section. This is the only way in which you can really arrive at the greatest economy; and it is very easy in the case of using approximate figures in the first place—you do not waste a great deal of time; it is only when you get nearly to the final result that you need go to at all accurate figures.

Now comes the question, In the transmission of power to great distances, what kind of apparatus are we to use? Are we to use continuous currents? Granted that we are to use high-tension currents, are we to use continuous currents, or are we to use alternating currents? I think that if this question had been asked a couple of years ago, you would have found that nine men out of ten would have answered you that there was nothing open for use except continuous currents. In fact, at the time that the question was in discussion in respect to Niagara, the Commissioners who sat and considered the different proposals which had been made, as nearly as possible passed a general resolution, for the guidance of the syndicate which had the concession at Niagara, that it was impossible to use alternating currents for the purpose; and yet, within this short space of time, what a transformation has taken place. I suppose that it is more due to the extremely interesting experiments which were carried out at Frankfort during the last year than to anything else, that such a change of opinion has come over the minds of men generally. I suppose that, if the same question were asked again at the present moment, not only would there not be nine persons out of ten who would say that the continuous current was the only one, but I doubt whether there would be more than one out of ten who would say so. I do not in the least wish to undervalue the continuous current and its capabilities of transmitting power at high pressure. I have seen cases where this is being done, and I feel sure that

with proper precautions it can be done well. Monsieur Thury, of Geneva, acting for the firm of Cuénod, Sautter, and Company, has erected at Genoa and Geneva, and a number of other places, high-tension continuous current dynamos. They couple them in series, so as to increase the pressure. The machines are worked up to about 6,000 volts, and they are prepared to go to greater voltages, using 2,000 volts in each machine. The machines are completely insulated from the ground, being put on piers, built up of alternate layers of vulcanised india-rubber and pieces of porcelain. The difficulty

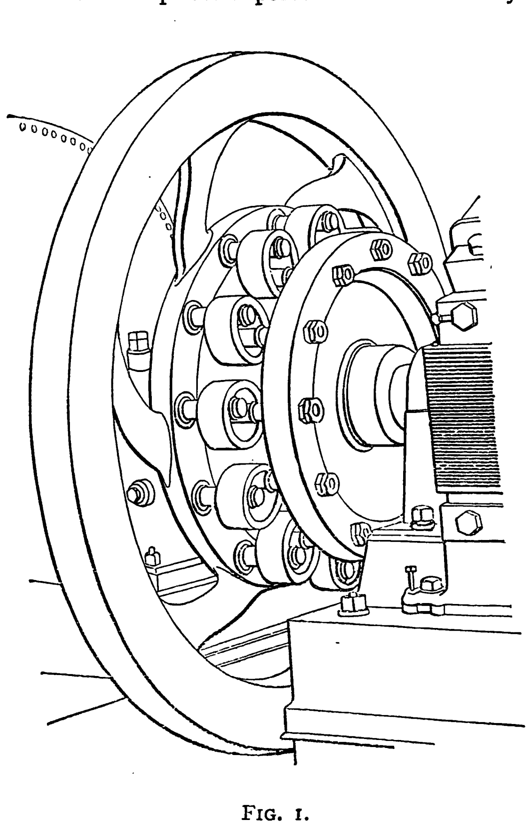

FIG. 1.

which many people thought they saw was the connection with the source of power — the water-wheel or the steam-engine — but the firm to which I allude have always used the Raffard couplings, and have been entirely successful with them; and I have no hesitation in saying that it is a very satisfactory arrangement. The Raffard coupling is an extremely simple thing, and of use when we wish to connect two axles together in a line. We place upon each of them a disc (Fig. 1), one of larger diameter than the other. An equal number of pins project through their adjacent faces, near the periphery of each of them; and these two sets of pins, which overhang each other, are connected in pairs by rings of india-rubber cut off an india-rubber pipe. The result is a flexible coupling, which is extremely valuable mechanically, and which is a perfectly insulated coupling. There is not the slightest difficulty in connecting high-tension machines to engines or turbines with this arrangement, which works perfectly well in practice.

The machines which are at our disposal with alternating currents are enormously varied in character.

First, let me speak a few words about the ordinary continuous current motor with a commutator. When we use alternating currents with them, of course it is essential to have the field magnets laminated, or made of sheets of thin iron, in order to prevent the waste due to the formation of eddy currents—Foucault currents, as they are called—in the iron of the field magnets. Even then the machine will not work with the alternating currents of high frequency; but I stated, in my last lecture, that it is practically certain that, when we come to the future of alternating current distribution, we shall be dealing with very much lower frequencies than we have been dealing with in the past. With low frequencies such continuous current motors will work extremely well. As I said in my last lecture, referring to this question, an ordinary 10 horse-power continuous current motor with laminated fields, made for 100 volts, would, owing to the self-induction of the circuit, have its output reduced about 50 per cent., because 100 volts being required for working the armature, another 100 volts would be required for getting over this self-induction; whereas, if we reduce the frequency of alternation down to the frequency which occurs in the armatures of ordinary continuous current machines, we should only be using six volts out of 100 for this purpose; so that we might say that it is within the range of practical working. Simply for distribution in a town, if the question were asked at this present moment, it is quite possible that it is this type of motor which it would be most desirable to use. The reason is that this motor, arranged for alternating currents by having its field magnets laminated, is able to do exactly the same work as the continuous current motor is at the present time; that is to say, it is able to be stopped and started as frequently as you please with the utmost convenience, and, moreover, it has the enormous advantage of producing greater

force tending to turn it at the moment when we start it, than when it is running at its full speed. The very fact of your having a larger current going through it at the start magnetises the field magnets to a greater extent and increases the turning force—the torque—which is moving it. That is a particularly desirable thing in the case of machinery in workshops and so on; but, of course, it is of the greatest importance in the case of our tramcar motors. All tramcar motors at the present time use continuous currents, but, if we were wishing to use alternating currents, it is quite probable that at the present moment this type of motor would be the most suitable and most readily available; and it is more in working tramcars and electric railways that we find the tremendous want of a powerful starting torque—that force at starting, and where the value of the series-wound continuous current motor is so great. That advantage would be reaped also by the same type of motor used with alternating currents.

I have spoken about the possibility of using alternating currents for electric railways and tramways. You might say that there is no advantage in using alternating currents for that purpose; but when we come really to examine the practical cases, such practical cases as are before the engineering world at the present moment, looking at the experience of the South London Electric Railway and looking at the Central London Electric Railway which is being planned for at the present moment, and looking at the half-dozen other lines for which there are Bills in Parliament at this moment, we find that the alternating current possesses a very great advantage over the continuous current. When we are carrying our conductors to great distances, as in the Central London Railway for instance, a distance of many miles, just as the South London Railway generating station is miles distant from other parts of the line, we find that in continuous current working at only some 400 or 500 volts we have an enormous loss in our leads, and we have an enormous expenditure of copper in our mains going to these distances. Here our conductors are not buried underground. The expense of laying our conductors is not, as in the case of electric lighting generally, the expense of going underground, and getting round pipes, and getting over other difficulties. Our expense in conductors here is simply in the copper which we put into them. Now, here we have the total gain which the alternating current is able to give us. It is altogether gain here; and if we are able to carry the alternate current by means of high tension over this long distance, and to transform it by means of that most efficient appliance, the alternating current transformer, down to lower pressures at the place where it is required for working the tramcar or the locomotive, in that case the alternating current will be giving us an enormous advantage over the continuous current. Consequently, it is extremely likely that the alternating current will be adopted in some of these schemes, which are actually before engineers at the present moment; and if such a scheme had to be worked by the alternating current at this very moment, I think that it is extremely probable that we should use alternating currents of very low frequency, alternating some five or ten times per second, using high tension in the mains, and low tension in the secondaries, and using the very continuous current machines with laminated field magnets that I have been speaking of for the purpose. That is, at the present moment, probably the solution that would be best; but the improvements and advances which are being made in the use of the alternating current with motors are so enormous, that I would not say that in a few months the facts may not be different.

I wish now to say a few words about a type of machine which has attracted considerable attention in the past, and which, for certain purposes, is probably the best which can be used, that is, the synchronizing alternating current motor. This is simply an ordinary alternating current machine—a dynamo machine for producing alternating currents. It is put upon the circuit and made to work as a motor, and it works as a motor when once you have given it its necessary speed. The motor must be going at the same speed of revolution as the generator of the electricity, otherwise this type of motor will not work.

It has been somewhat of a puzzle to a great many engineers—certainly it has been a great puzzle to the "practical" man that I was speaking of a short time ago—to understand what was the reason that some alternating current dynamos worked so well as motors and some did not. I think the question has been rendered perhaps a little more puzzling by the explanation having been so completely given in certain cases by Dr. Hopkinson. Dr. Hopkinson, some years ago, read a paper before the Institution of Civil Engineers, in which he showed that the self-induction which

is inherent in the alternating current machine tends to keep together the two machines when they are acting as generator and motor, and prevents them from getting out of step, and that, therefore, there is a certain amount of power which can be transmitted from the generator to the motor, and the motor can be made to do work. He elaborated this in an extremely interesting paper before the Institution of Electrical Engineers. As soon as these facts were established, a number of the so-called "practical" men immediately set to work to make machines with as much self-induction as they possibly could; and they altogether defeated their aims. The astonishment of many of these men was very great when Mr. Mordey read his most valuable paper —also before the Institution of Electrical Engineers—in which he showed that his dynamo machine, in which there is very little self-induction, and in which there is no iron in the stationary armature, works as a motor most admirably. He gave results which had never been excelled by any alternating current motor that had been tried, and yet there was very small self-induction in the machine at all. This was rather a puzzler for such men; and, finally, the puzzle was complete, when a comparison was made between such a machine as the Siemens alternator, which you all know, and the Mordey alternator. The Siemens and the Ferranti are both the same. The only difference between the Siemens or Ferranti alternator and the Mordey alternator is that, in the one case, the armature revolves, and, in the other case, the field magnets revolve, otherwise they are practically identical, from an electrical point of view. Yet the Mordey alternator acts most admirably as a motor, and the Siemens or Ferranti machine does not work as a motor. The reason is simply this, that the power which is being given to an alternating motor is, of course, of a pulsating character, like the current; and there are moments when no power is given to the motor at all. If, then, the motor is doing work, it requires to have a considerable momentum to get over those dead centres, and to be able to continue doing the work, and to get past those dead centres, when the generator is giving out no power whatever. Now, the Mordey alternator, in which the field magnets rotate, has an enormous momentum; but the Siemens or Ferranti alternator, where the armature rotates, has very little momentum indeed; and the consequence is, that while the Mordey alternator works admirably as a motor, the Siemens or Ferranti alternator does not. All you have to do with the Siemens or Ferranti alternator, to make it work as a motor, is to put a big fly-wheel to it. There is another method available. Suppose we take two of these alternators, and connect them together on the same shaft, and make them act as a generator for two separate currents going along separate wires; and suppose that for our motor we use two similar alternators, also coupled on a common shaft, each alternator in each pair being electrically separate, so that the one gives or receives its maximum current when the other is giving or receiving its minimum current. One of the generators is feeding one of the motors, and the other generator is feeding the other motor, and the two generators are on one shaft and the two motors on one shaft. Each of these pairs has got some dead centres. One generator and motor on one circuit have a moment when the motor is at a dead centre; but at that moment the motor of the other pair is not at a dead centre, but is at full work, so that at the moment when one motor, having no momentum, would naturally stop, the other one is driving it on. But it, in its turn, when it comes to a dead centre, is driven on by the first one which is then in full swing. This is exactly analagous to the method adopted in the ordinary locomotive for getting over the difficulty of dead centres. There we have two cylinders working the driving wheels. One alone would be sure to stop at a dead centre sometimes, and stick and refuse to start the engine; but, by having two cylinders so arranged that the one is giving its maximum thrust at the time the other is giving no thrust, they are always, when they are at rest, in a position to start the engine. That is exactly analagous to the method I have suggested in connection with the Ferranti alternator. That arrangement which I have just now described is really a way of arriving at the rotating phase motors which have created such interest in the course of the last year. This is not the exact arrangement which has been used generally in the rotating phase motors, but it is one which has been used by some makers and which works successfully. In the great electrical exhibition which was held at Frankfort last year there were a number of motors shown by different constructors, notably some by Mr. Schuckert, in which a continuous current dynamo was used, but from the wires of the armature of this continuous current machine wires were led, not to a commutator, but to

rings fixed on the shaft of the motor. Four wires equi-distant round the armature were taken to four rings, and from these he was able to take off two alternating currents going along two separate circuits to a distance, to another machine similarly fitted up. Each machine, you understand, possessed a commutator because it was a continuous current machine; and it also possessed these four rings from which the current could be collected in the form of alternating currents. One of these machines being used as a motor and the other as a generator, we had all the advantages that I have just been speaking of. We had exactly the same effect as if we had had two Ferranti dynamos joined mechanically together on the same shaft and shifted through a distance corresponding to a quarter of a period. These machines worked extremely well. They were able to start, too, though not at full load. The method of starting them was not to excite the motor in the first place, but to leave the motor not excited; the current which was created in the armature induced currents in the field magnets which tended to assist in starting, and very soon synchronism was obtained; as soon as the motor was going at its full speed the brushes were switched on to the commutator, thereby magnetising the field magnets, and the motor then ran as an alternating current motor exciting its own field magnets.

At the time that the question of utilising Niagara was very prominently before the world, I had to give my opinion as to what was the best method of transmitting the power. That was in the year 1890. I stated then that, simply adopting machinery which we had thoroughly tested, and which we knew would not fail us, the best method we could possibly adopt was that of using alternating currents, and that the best way of using alternating currents was to use synchronising motors, such as the Mordey machine. I specially mentioned the Mordey machine because I had found it work so extremely well under all circumstances. I confess that I had had, perhaps, some special advantages which enabled me to see that this was really so satisfactory a machine for transmitting power over this distance. I had not only had special opportunities of testing very thoroughly the Mordey machine, and the Siemens machine, and the Ferranti machine, but I had also an opportunity of testing the Tesla machines, which were made at Pittsburgh; and I felt at that time that the Mordey machine was the one which was most suitable for the purpose. Our object at that time was simply to transmit power. The distribution of the power through the town was of secondary importance. But even then I proposed to distribute the power through the town to large factories, which require to have their machines running all day, simply by the alternating current, transformed down from 10,000 volts to 2,000 volts, because you cannot safely carry—or, at all events then, I could not recommend that you could safely carry—10,000 volts through the streets underneath the ground. You would have it then of 2,000 volts going to the large factories. For smaller shops and places, the proposition was to convert our high tension alternating current into continuous current outside the town, and then carry it into the town for use with small continuous current motors. That was the solution at that date.

Seeing that the rotating phase motors have been such an enormous success, you may ask me why it was that I did not then consider that the rotating phase motors were the best. I am not sure that they would be the best even with the experience which has come since; but at the time I felt that, since no motors had been at work on this principle of larger size than a very few horse-power, it would be a rash experiment to go immediately up to machines, the smallest of which would be 1,000 or 2,500 horse-power; and although there was every promise in the Tesla machine, and although I proposed that we should arrange things so as to be able to introduce the Tesla machine as soon as it was made on a larger scale, I did not think that the ordinary transmission over the distance from Niagara to Buffalo ought to be done by means of this machine. And at the present moment I still think that the synchronizing motor is the best possible for that purpose. But with the enormous stride that has been made by the genius of Mr. C. E. L. Brown, of Switzerland, in the design of those machines that were shown at Frankfort, there is every reason to believe that we shall have a much greater efficiency.

Let me explain the principle, very briefly, of these rotating phase motors. Here is a diagrammatic illustration—a section of one of these machines (Fig. 2, p. 893)—in which we have four poles opposing each other, and an armature in the middle. The armature is supposed here simply to be wound like a drum armature, and to be short-circuited either at both ends, or at the commutator end. In

fact, the armature, for all practical purposes, may be supposed to be simply the ordinary drum armature of a Siemens' machine, with the commutator wound round with a bare copper wire, so as to be short-circuited at that end. The armature conductors are closed upon themselves, and have no current coming in from the outside. There are two currents coming to the motor from the generating station in different phases. One current circulates round the two horizontal magnets, their polarity, at any moment, being of opposite kind. The other current circulates round the two vertical magnets. The one current is at the maximum when the other current is at the minimum, and one current is always just a quarter of a phase in front of the other current. The consequence of this is, that the magnetism which is induced in the armature

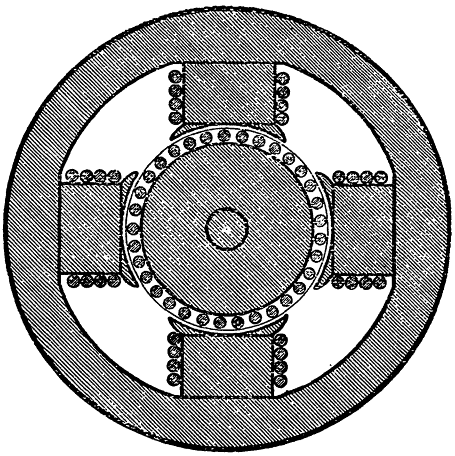

FIG. 2.

will at one moment have a horizontal direction; a little later it will have a vertical direction; a quarter of a period later again, it will again have a horizontal direction, but opposite to what it was before—that is to say, the polarity will be reversed, and so on. It will be seen that, as the magnetism of any pole continually changes gradually from zero to a positive maximum, again through zero to a negative maximum, every complete period; and that the successive poles round the machine differ from each other's condition by an amount corresponding to a quarter of a period; there will be what is equivalent to a continual rotation of the whole magnetic field round the axis of the machine. The lines of force, in cutting through the wire of the armature, induce electric currents in the wire, of course; and since the armature opposes the creation of these induced currents in the wire, a natural mechanical opposition is offered to these wires being cut by these magnetic lines of force; and the consequence is, the armature is carried bodily round, and tries to turn round at the same rate at which the magnetic field is travelling round, in which case the conductors would not be cut at all by the lines of force. That is the general principle of the machine, which was independently invented by Ferraris, of Turin, and Mr. Tesla. The results of the official experiments which were made at Frankfort have not yet been published, and consequently we are hardly in a position to speak of the value of them; but I may say that we have not the slightest doubt that this system of multiphase transmission is an extremely effective mode of transmitting power, and that it opens a new field, and is equally suitable for distribution and for transmission, and in that way has an enormous advantage over the simple alternating current system with synchronizing motors. It has all the advantages of simple alternating currents, in that we can use low-tension dynamos, which are perfectly safe things to deal with, and which can be made of thoroughly mechanical construction; we can increase the pressure by means of a transformer, and carry the power to a distant station; lower the pressure there to such a pressure as is convenient for distributing through a town, and then take it off at the houses where the motive power is required, and drive our motors. That is to say, it has all the elasticity of the ordinary alternating current system; and its motor has the enormous advantage over the synchronizing motor in that it is a machine which is suitable for placing in workshops—one which you can start and stop as often as you please. One of the greatest uses of electrical motors in workshops, with which I am acquainted, is their use for cranes, especially travelling cranes. There are many other cases where it is highly useful for replacing shafting and for the working of machinery. In all these cases we need to be continually starting and stopping the motor. We cannot leave the motor continually running; and it is essential for these purposes to have some motor like this rotating phase motor, in which we can start frequently and effectively. We have had no tests published of the Frankfort trials as to the power of starting, but I may perhaps interest you by giving you, in concluding this lecture, a few results of experiments which I made this afternoon with such a rotating

phase motor, as I do not think that any results have been published at all. I will only just give you one or two results. I will give you one just to show you what work the machine was doing. It was not doing a very great deal, but I will give you an example of what it was doing. The alternating generator was driven by means of a continuous current motor, the current being supplied to it from the mains of the Westminster Supply Company. That alternating generator supplied alternating currents to one of these rotating phase motors. That motor in turn was caused to drive a continuous current dynamo machine, and it supplied a number of lamps. We were able to measure the volts and ampères which came in from the Westminster Company, and the volts and ampères which went to the lamps; and we could get an idea of the amount of work which was being done by this motor.

With the first continuous current motor we had 102 volts in one experiment and 39 ampères. And on the lamp circuit where the work was being done we had 89 volts and 9½ ampères. That shows that we were getting something over a horse-power from the motor. That is the only reason that I put down these figures. You must not take these figures as representing the efficiency of the alternating motor in the least degree. They give us no information on this, because, in the first place, it was an inefficient motor which we were using to drive the alternator, and it was an extremely inefficient dynamo which we were using to generate the current for the lamps, so that we had really no test of efficiency whatever. But it gives you an idea of the horse-power which we were using. The motor was a motor which was giving us off about 1 horse-power in the lamps, but it was working up to a higher figure. Now an interesting experiment was to find what power there was at starting, and I found that on a pulley having a diameter of about five inches, there was a pull of about 40 lbs., when the alternating motor was supplied with current at the same pressure as in the previous experiments; that is to say in the ordinary working of that alternating motor as at that time, we would get a pull of about 40 lbs. on a pulley of five inches. The speed at which we were going in this experiment was 1,380. Now the pull at 40 lbs. which I found on the pulley would have given us 2 horse-power at that speed. Consequently the torque at starting was extremely good; and although this is a very rough experiment, it is of the greatest interest to myself to have the measurement of the starting torque with such a motor, because I have not been able to get any other actual measurements of any sort whatever. We shall get more accurate experiments very soon no doubt, but this is the first step in the right direction.

Miscellaneous.

TEA CULTURE IN ASSAM.

The report on tea culture for 1891 issued by the Assam Government is quoted in the *Board of Trade Journal*:—

"Following the practice of previous years, figures are given separately for each sub-division, in addition to the totals for each district. Cachar sadr still heads the list with the largest number of gardens (138); Lakhimpur sadr comes next (130); the former also shows the largest area under tea and the largest out-turn. In the Brahmaputra Valley, North Lakhimpur shows the highest proportional yield of 572 pounds per acre, while in the Surma Valley, Habiganj heads the list with 649 pounds per acre.

"The total number of gardens borne on the registers at the close of 1891 was 828, against 867 at the close of 1890, and thus showed a net decrease of 39. There was a decrease of 43 in Kamrup, as against an increase of 10 in Sibsagar, and 14 in the other districts.

"The apparent increase of 10 gardens in Sibsagar is due to the inclusion, in this report, of nine small gardens in Jorhat, which were excluded from the previous year's reports, owing to the managers not having supplied the necessary statistics in those years. The decrease is largest in Kamrup, where 28 abandoned gardens have been struck off the register this year. Besides these, 13 gardens in this district, which were not worked, owing to depression of trade, and were hitherto shown under head "Estimated," have been excluded from the present report, in accordance with a suggestion made by the Commissioner of the Assam Valley Districts. Assuming that the above 13 gardens were included among the 22, shown as unworked in paragraph 5 of the preceding year's report, and excluding the nine gardens in Sibsagar, included for the first time in the report, and referred to above, the actual reduction in the number of gardens in the whole province would amount to 35.

"The large increase in Cachar is attributed by the Deputy Commissioner to an attempt made to include in the tea register the areas that have been newly taken up annually by tea planters. In the Brahmaputra Valley, Kamrup shows a considerable decrease in the area held by tea planters, which is due to 41 gardens having been removed from the register

during the year (13 unworked and 28 abandoned). The decrease in Darrang is accounted for by the four gardens closed, and that in Nowgong is due to the readjustment of the boundaries of the waste land grants by the cadastral survey, no new land having been taken up during the year. The increase in Sibsagar has not been explained, while that in Lakhimpur is attributed to the new gardens opened during the year.

"The statement below gives for the last six years the areas under mature and immature tea plants, and the total area held by tea planters:—

Year.	Under Mature Plants.	Under Immature Plants.	Total Area of Land held by Tea Planters.
	Acres.	Acres.	Acres.
1886	170,138	33,855	934,134
1887	177,900	33,179	950,171
1888	188,329	28,347	955,499
1889	196,689	30,560	1,000,665
1890	200,658	30,380	994,497
1891	208,407	33,416	996,746

"The above shows an increase under all the heads, that in area under mature plants being a steady one. The increase in area under mature plants, which has been general in the Surma Valley and in the upper districts of the Brahmaputra Valley, is due to 'immature' plants passing to the category of 'mature' after their fourth year of growth. Silchar, Habiganj, Gauhati, Nowgong, Sibsagar, and Golaghat show a decrease in area under immature plants, which is partly due to the above reason, and partly to extensions not keeping pace with the progress of plants from immature to the mature stage.

"In the statement below figures are given showing the total area under cultivation for the last two years:—

District.	Total Area under Mature and Immature Plants.		Increase or Decrease.
	1890.	1891.	
	Acres.	Acres.	Acres.
Cachar	56,562	58,793	+2,231
Sylhet	43,196	46,428	+3,232
Khasi and Jaintia Hills	30	30	—
Goalpara............	397	425	+ 28
Kamrup	6,361	5,131	−1,230
Darrang	21,327	23,134	+1,807
Nowgong	11,868	11,886	+ 18
Sibsagar	54,940	58,370	+3,430
Lakhimpur	36,357	37,626	+1,269
Total	231,038	241,823	+10,785

"The increase in Cachar, Sibsagar, and Lakhimpur is due to recent extensions. The Deputy Commissioner of Sylhet attributes the large increase in his district to the extensive areas put under tea year by year in all sub-divisions, which have now come under the category of 'mature.' No reason has been given for the increase in Darrang, except that the figures are only approximate, estimates having to be made for 11 gardens, some of which have not furnished returns for many years. The variations in other districts have not been sufficiently accounted for.

"The total out-turn of tea in 1891 is reported as 90,399,362 lbs., being an increase of 8,280,110 lbs., or 10·08 per cent. over the previous year's figures.

"The following statement compares the figures furnished by the Indian Tea Association and the Trade Returns with those reported by the Deputy Commissioners:—

"Out-turn according to India Tea Association.—1890, Brahmaputra Valley, 45,416,721 lbs.; Surma Valley, 31,472,703 lbs.; total 76,889,424 lbs; 1891, Brahmaputra Valley, 50,967,373 lbs.; Surma Valley, 38,696,664 lbs.; total, 89,664,037 lbs.

"Out-turn according to trade returns.—1890, Brahmaputra Valley, 46,703,973 lbs.; Surma Valley, 32,016,795 lbs.; total, 78,720,768 lbs.; 1891, Brahmaputra Valley, 46,418,277 lbs.; Surma Valley, 34,563,950 lbs.; total 80,982,227 lbs.

"Out-turn according to Annual Tea Report.—1890, Brahmaputra Valley, 48,144,401 lbs.; Surma Valley, 33,974,851 lbs.; total 82,119,252 lbs.; 1891, Brahmaputra Valley, 50,643,374 lbs.; Surma Valley, 39,755,988 lbs.; total 90,399,362 lbs.

"The trade return figures are, as usual, the lowest, and those furnished by the district officers the highest. The difference between the latter and the Indian Association figure is not, however, so large this year, being only 735,325 lbs., as against 5,229,828 lbs. in 1890. All the three sets of figures point to a growth in production which, moreover, has been continuous for some years.

"Thus, the yield in all districts, except the Khasi and Jaintia Hills, Kamrup, and Nowgong, has increased. Darrang, which showed a slight falling off in 1890, has much improved this year, while the decrease in Kamrup, which is attributed to short rainfall and want of labour, still continues. The same reason is given for the decrease in Nowgong. The large increase in Goalpara, viz., 29·43 per cent., against 1·49 per cent. in 1890, is rather curiously explained. For instance, while one manager puts it down to the 'peculiarity of the season,' and 'uneven distribution of rainfall,' another says, 'the season has been an exceptionally good one, and has increased the yield.' The Deputy Commissioner adds as his own opinion—

"I believe the season was a very bad one for want of sufficient rain throughout the year. The increase in the yield may have been caused by the increase in the number of mature plants."

PRODUCTION OF INDIA-RUBBER IN NICARAGUA.

India-rubber is obtained in Nicaragua from the *Siphonia elastica*, a tree from fifty to sixty feet in height, and no india-rubber has as yet, it is said, been obtained from any other source. The native name for rubber is *ulli*, and the United States Consul at Managua states that this was a term applied to it by the Aztecs. The Spaniards called the collectors of it *ulleros*. Some authorities in the country claim that the rubber tree of Nicaragua is not the *Siphonia elastica*, but the *Castilloa elastica*. There are several methods of obtaining the rubber employed by the hunters, but the principal are those described below. The large rubber trees are generally felled, and incisions about 2 inches deep and 2½ inches wide at the top are made round the tree at distances of about a foot apart, and the rapidly flowing milk collected, through funnels formed of leaves, into calabashes, each capable of holding from three to five pints, or in holes made in the ground and well lined with leaves. Another method employed is to cut into the tree near the top and down to its base, one, two, or three vertical channels, according to the size of the tree, through the exterior bark into the lactiferous vessels, and frequently through these vessels into the woody fibres; then cutting numerous oblique channels on each side of, and connecting with, the vertical ones. This work requires ladders, which the rubber hunters improvise either by using the vines on the trees which they intend to scarify, or cut from the numerous meshes of vines found handy in the forests; by these the *ulleros* ascend the trees and commence their work near the top, and continue cutting one or two vertical, and numerous oblique connecting channels uninterruptedly, until they have completed them. They work rapidly in order to keep in advance of the fast flowing milk. The milk is conducted from these channels by the means referred to above. A third method used by the rubber hunters is to scrape off the outer bark of the trees with a *machete*, commencing eight or ten feet above and extending down to within one or two feet of the ground. Clay alone, or a vine and clay, are placed around the tree, inclined so as to form a ridge about two inches high on the lower edge of the scraped or bark-removed part of the tree. This guard is sufficient to direct the rapidly flowing milk or emulsion into the receivers at the foot of the tree. In order to make the milk coagulate rapidly, the Indians or rubber gatherers make a decoction from the vine which they find twined around the trees, and this has been found the most efficient means of producing coagulation. This decoction on being added to the milk, in the proportion of one pint to a gallon, coagulates it to rubber, which is made into round flat cakes. Sometimes the fresh milk is mixed with the coagulating decoction, and then heated up to between 160 and 170° Fahrenheit, in the calabashes, and with a result apparently of a more elastic and less gummy india-rubber than that obtained by any other process. As the number of rubber trees becomes less, the methods employed in gathering the rubber become different. A few years ago the trees produced from ten to twenty gallons of milk, and the rubber hunter would then take the milk and put it into a large hole in the ground and make a cake of it, known as *torta*, but now that the trees do not yield a great quantity of milk, the plan of making a hole in the ground is fast being done away with. The best rubber is considered that which is taken from the long channels, which the *ulleros* cut in the trees, after the milk has been allowed to remain in the channels from one to two weeks. The rubber is known as *borricha*, and it is considered to be superior to all other because it contains less water. The natural supply of india-rubber is yearly decreasing in Nicaragua. The cause of this is the habit of the natives, until lately, of cutting down the trees, thinking that they could thereby secure more milk. The Government attempts no supervision of the forests; anyone may cut the trees, and great destruction is caused by the young trees being tapped as well as the full-grown ones. Consul Newell says it is an incontrovertible fact that, so far, at least, as Nicaragua is concerned, the rubber tree is susceptible of cultivation, and in the district of Managua there are large tracts of land suitable for growing rubber trees. The rubber section of Nicaragua is that portion extending from the mountains in the vicinity of Chontales, the north-eastern part, to the Atlantic coast, and it is the opinion of those persons in Nicaragua who are interested in rubber production, that the cultivation and improvement of rubber plantations would be very profitable.

General Notes.

ARTISTS' COLOURS.—With reference to the recent discussions in the Society as to the permanence of modern pigments, it may be interesting to quote the opinion of Sir Frederick Leighton, as expressed to the writer of an "interview" lately published in the *Strand Magazine*:—"I consider that the colours used to-day, if properly prepared, ought to be far better and much more durable than those of the past. In the days of Sir Joshua Reynolds and Wilkie, during the reign of asphaltum, a colour used very largely then but now quite out of use, the pictures suffered very much. Although I have been painting in oil exactly fifty years, I have only had one single accident happen with a pigment."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Wednesday, 7th inst. Present:—Sir Frederick Abel, K.C.B., F.R.S., in the chair; Alfred Carpmael, R. Brudenell Carter, F.R.C.S., Francis Cobb, James Dredge, John O'Connor, with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

CANTOR LECTURES.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

By Prof. George Forbes, F.R.S.

Lecture IV.—Delivered February 15, 1892.

In my last lecture I was dealing principally with the question of using water power in connection with electric lighting and electric power. There are two engineering problems, important to engineers, in connection with the use of water power; one is where we are using it simply for lighting up a very small place, and one frequently has to deal simply with the lighting-up of a single country house. The extreme case, on the other hand, is the transmission of power to great distances, where you want to utilise a waterfall, and bring the power into a town and use it there for motive power or for lighting. These are two very distinct problems, and there are several points in each of them that need particular attention. It may be worth while to introduce a word of caution in connection with the use of water power for lighting country houses. I have found from experience that the very greatest caution is necessary in utilising water power that may seem to be perfectly available. In the first place, it is generally extremely difficult to find out what is the exact amount of power which can be obtained from the source of the supply. Of course the water power in this country is generally superabundant in winter, and diminishes in summer. That is a fortunate thing for us, and suits the demand for light; but it becomes extremely doubtful whether the supply of water which we can get in the very driest time of a dry summer will be sufficient for our purposes. I may say that, whenever it appears, from observations that you may take at any one time, that there is the slightest doubt it is the most injudicious thing to set up turbines and plant for utilising the water power without having taken measurements of the flow of water, at least during one summer, and thus judged as to the probability of the supply during a particularly dry summer. But there is another equally likely catastrophe to happen, which is far more serious and important, and that is that in a great many places, where it appears perfectly certain that we shall have enough water during the whole of a dry summer, there may come on a heavy frost in the winter, which will freeze up the source of a stream, and prevent us from getting our power in mid-winter. The fatal effect of such a thing is evident, because it is in mid-winter that we want our light most; but it sometimes happens that a small burn that we intend to use for electric lighting, which the inhabitants around may tell you certainly never freezes, and that the flow in winter is always superabundant, may sometimes be found to freeze, and you are deprived of water power in the very middle of the winter. In such cases, however, it very frequently happens that it really would be a saving of expense to introduce turbines, besides having an auxiliary boiler and steam-engine for cases of emergency. It is a large additional expense to the original plant, but it is in most cases extremely useful and very economical, when we consider the saving that the water gives us in the consumption of coal during the greater part of the year.

But there is another point of economy which sometimes has not enough attention paid to it, and that is when the source of water power is not exactly on the premises or where you want the power to be used. It very often happens, in a country house, for instance, that the power is at a distance of, say, half a mile from the house. Now, even the distance of half a mile is serious, when you come to calculate the size of the conductors which will be required to convey your current from the source

of power to the house. Too often people have gone upon the assumption that the cables would not have to be very large, and have been disappointed in this way, and have thus been led to very considerable expense.

With regard to the extreme case of using water power for transmission to a distance, and, it may be, subsequent distribution through a town, I spoke pretty clearly on the last occasion; and while at the present moment most cases of transmission would be best done by means of the alternating current, I can quite see cases where the continuous current is the most applicable, and there is no reason why we should not transmit our 10,000 volts or so by means of a continuous current for such purposes, only taking far greater care for matters of safety, because the dangers of a machine with a commutator are very much greater than with an alternating current machine. Of the means available for using the alternating current, as I have stated, there are two which may be considered, at the present moment, as decidedly the best. The one is by means of synchronizing generators and motors, which are ordinarily alternating current dynamos, working synchronously with each other; and the other is by means of the rotary phase system of transmission. I pointed out, at the end of the last lecture, that, while light alternators will not work well as motors when they are used singly, with a simple pair of conducting wires, you may use them in pairs, receiving two different currents in different phases from a similar pair acting as generators, one receiving its maximum when the other is receiving its minimum; that that arrangement enables us to get over the dead centres; and that such a machine, if it is extremely light, will start with a good pull from the beginning, and will do transmission work extremely well. Thus it appears that two Ferranti dynamos arranged in that way will make a generator of two currents, and will work as a motor also, and will work well, and will start well as a motor; whereas the Mordey alternator, which I contrasted with it in the ordinary way of working, has a very massive rotating part, and in consequence of that, it will not start as a motor so well as a light machine, when we are using two separate currents. Thus we have the curious fact that the heavy Mordey machine is the better as a synchronizing alternator of the two, whereas the light Ferranti alternator is the better one, where you are using two currents in different phases. Lately, in America, the dynamos which had been used for generating continuous currents for tramways by the Westinghouse Company have been fitted with rings for use instead of the commutator; four rings for taking off two alternating currents, one giving its maximum when the other current is giving its minimum. These large powerful machines have been working admirably as motors; they start very readily indeed; and of course continuous currents can be then taken off, on the same sort of principle as was shown by Mr. Schuckert at the Frankfort Exhibition, which has been talked of a good deal since. That machine has been very largely adopted indeed, and has been doing admirable work.

Coming now to treat of another matter in connection with water power, I wish to draw attention to what has been done in Switzerland in the way of utilising water power. Last summer I had the advantage of travelling with Professor Unwin through Switzerland, our object being to study the various cases where the natural power of water had been utilised for transmission to a distance, whether the means for transmission was electrical or by wire rope, or by any other means. I regret extremely — no one can regret more — that Professor Unwin was not able to give his course of Howard lectures here on the transmission of power to a distance. Those lectures would not only have been of the greatest interest to everybody who would have been here to hear them, but also of the utmost importance to engineering science generally at the present moment, when so much attention is being given to the transmission of power to a distance in every way. However, we found, as is well known to all of you, that Switzerland is quite in the front rank in the utilisation of water power, and in its transmission, whether it be by electricity or by any means. The engineering talent of Switzerland, compared with its population, ranks higher, I should say, than that of any other country in the world, whether we speak of its roads, its railways, or its large works for the utilisation of water power. There were two towns in Switzerland which attracted our most particular attention from the somewhat similar plans which had been adopted, and the admirable way in which they had been carried out, viz., Geneva and Zurich; and since they are so similar in their general principles, I will confine my attention principally to speaking of the Geneva works. In Geneva the power of the River Rhone, where it leaves the Lake

of Geneva, is utilised, and the fall varies from 6 to 12 feet. In Switzerland the maximum flow of water is in summer, and not in winter, as in this country, owing to the melting of the snow being the cause of the floods. Very large turbines must be erected, of course, with that low fall, and a number of turbines (nearly 20) have been erected to give in all 6,000 horse-power. This is a very large work, and involved a very big capital expenditure, but it certainly is to the credit of the Swiss Republic that when they vote money for large works for the State, the money all gets into the work. The same is not the case with all republics, and it is through the combination of great engineering talent, and this strict supervision over the expenditure, that these great works have been accomplished. The consequence is that, although an enormous capital expenditure has been necessary at Geneva, there is an ample return on the money invested.

The way in which these turbines are utilised is to supply motive power to the small factories that are distributed all through the towns. Watchmaking and other trades that are carried on in Geneva require a deal of small power, and the way in which this is done is by utilising these large powerful turbines with a small head of water to pump water up to a distant reservoir some three or four miles off, which gives a very large head of water, and then from the pipes connected with the reservoir other pipes are led throughout the town to distribute the power, and from these motors are supplied direct; the charges for the motors being generally made at so much per horse-power. This system is exceedingly effective, and a most valuable report has been drawn up upon the subject by Colonel Turrettini, who superintended the work, and I might have given you a great many extracts from that report containing much interesting information, but my reason for drawing attention to it is not so much to describe the details of the hydraulic work as to draw subsequently a moral from the manner in which its source of water supply has been utilised for the electric lighting of the town. This is carried on by a separate company, and you might naturally have thought that it would have been best for them to create their own power. The central station is situated on an island in the Rhone, close to the large turbines of the town, and it would have been natural, you would have thought, for them to utilise the power that is there available. They do not do so. They found that the terms upon which they can rent power from the town were sufficiently moderate to make it worth their while to do so, and to set up their electric lighting works independent of any source of power, although they were in the close neighbourhood of these turbines, and might have had turbines of their own. We consequently arrive at this somewhat anomalous arrangement as it might seem to you. There are powerful turbines on the Rhone pumping water to a reservoir three or four miles distant; the water from that reservoir comes back to within about 100 yards of the place where it was taken from, and is there made to pass through other turbines to generate power for driving the dynamos which light the town. At the first glance, it seems almost incomprehensible that there could be any economy in that; that instead of using the power on the spot you should first pump it to a great distance, and then use the water from that distant reservoir. In that case, one might ask why it would not do to put a steam-engine down, pump the water to a distance, and then use the water when it came back to drive your turbines; but, although it seems impossible that that could be a source of economy, as a matter of fact such an arrangement is an economical system, and the reason for it is that, when we are using steam-engines direct, as I pointed out in my first lecture, we are losing a great deal of the value of the coal that we are burning, first because the engines are during a large part of the time running light, but also because the boilers are consuming far more coal for the amount of work that is done than they would be if those boilers were continually working; so that really cases may arise where there is a decided economy in putting down a less number of boilers and steam-engines than would be required to give off the maximum current that may be required from a central station, and to use these engines for continually pumping water up to a height, if there could be found a place where a reservoir could be made in the neighbourhood of the town, and then use the water from that reservoir to flow through turbines, and drive our dynamos.

There are many places in this country where such a system is of very great economy indeed; and in any case where there is economy effected, I may say that the arrangement is an admirable one, and is extremely satisfactory in working. Any person who has ever used, or seen used, water turbines in a central station for electric lighting, must be convinced of the great facility it gives to the

proper management of the central station. The whole space occupied by the machinery is so very limited, the machinery is so easily regulated, the place is so clean, and so free from noise, that very little attendance is required, and the attendance is easily given and easily devoted to the purposes required. So that really, I can say from past inspection of such electric lighting stations driven in that way, a single attendant is able to manage the turbines, the dynamos, and the switches, and everything, and most of the time he has really nothing to do. The difference between this and having engine-drivers and stokers continually at work, and the difficulty of communicating orders, by shouting, it may be, owing to the noise, and the general discomfort of managing a very large station, instead of having it all compact in one place, is very striking; so that wherever such an opportunity of using water power occurs it is very desirable to take advantage of it. Now, as a particular example, I will mention the case of the city of Edinburgh. There it is possible to use the heights which surround the town for collecting the water. In the immediate vicinity of that town there is the hill known as Arthur's Seat, at a height of 800 feet above the sea. There is on this hill a loch already, called Dunsapie, which holds water enough to supply 1,000 horse-power for two hours. Anyone who is conversant enough with central station work will see that here there is the means of supplying sufficient power for doing the work of a large central station—in fact, driving one central station by means of the water power which could be derived from that reservoir; but with the utmost facility a dam can be built across a gully which there is near the summit of the hill, giving us a far greater height, and this dam would cost but little, owing to the natural construction of the hill; it would be invisible from all parts surrounding Edinburgh, save only in one direction, and even in that it would not be on the sky line, and would not be an injurious feature in the landscape, whilst to those who go up to the summit to enjoy the view, the lake which would be formed would be an extra attraction. There is really nothing in the beautiful features of the place to prevent that being done, and thus the amount of power which could be stored would be fully doubled. For working a station which requires the maximum of, say, 1,000 horse-power, we do not require an average in many cases of more than about 150 horse-power. What, then, we should have in this station would be engines and boilers for 150 horse-power continually working day and night, from week's end to week's end, employed in pumping water up through pipes to this reservoir on Arthur's Seat. In connection with these pipes, at or near their lowest part we should have turbines driving dynamo machines, for the distribution through the town. Instead of being obliged to have engines and boilers of 1,000 horse-power we should have them of only 150, thus saving an enormous amount in capital expenditure. If we do not require to build a dam, as we do not in the first instance, using the Loch Dunsapie which is there, the only serious item to consider, to be put against the boilers, is the pipes. These would come to something like £2,000, but the saving in capital expenditure on the whole is very great. But it is not only the saving of capital expenditure which is important, it is the annual saving in the coal bill. The pumping up of this water by an engine perfectly continuously can be done in the most economical manner that any work with steam-engines can be done; whereas, on the contrary, we know that in central station work for electric lighting we have one of the most uneconomical methods of using coal possible. We can get 1 horse-power available on the turbines, including the losses in pumping up and the losses in the turbines, for certainly very little over 3 pounds of coal per horse-power per hour used in the boilers; whereas in many central stations, as you know, they are going up to 10 pounds, 15 pounds, or even more of coal per horse-power per hour. There is then undoubtedly a most enormous saving in fuel besides the saving in capital expenditure, and for these reasons, wherever such a system is available, it will be desirable to adopt it rather than to put down the whole plant necessary for generating the maximum current which may ever be required. I worked out this pretty fully in the case of Edinburgh for my own satisfaction, and have already brought the matter before the authorities there, and I hope to see some such scheme adopted, not only there but in many other towns also where equal advantages are offered. In working out the figures I may say that the actual expenditure is very little more than half what it would be if we were putting down steam plant for the whole work, and the savings which are effected in attendance and fuel are, even when we are using coal for generating steam, very great indeed. It saves about one-third of the expense, not including

of course the expense of distribution of electricity, and so forth.

If I had to be contented with simply what I have told you up to the present moment, such a scheme would be of the utmost value in cases where it is applicable, but there is another source of economy which can be introduced, and for which this system which I have advocated is perfectly suitable. This leads me to the part of the subject to which I wish to draw your attention this evening, and that is the employment of destructors for utilising the refuse in towns—the ash-bin refuse, which at present costs an enormous sum of money to be got rid of, and which, in many towns, is simply tipped in the outskirts, and becomes a source of disease and danger, especially when the town expands, and building operations commence in the region which has been used as a tipping ground. The whole question of the disposal of town refuse is one of importance. It is one to which, I need hardly say, electrical engineers, as a general rule, have not paid much attention. I daresay there are comparatively few here who have really gone into the question of the use of destructors, and I should not be surprised if there are some present who have hitherto been ignorant of what a destructor was; in fact, a very well-known electrician last week, after I announced that I was going to speak about destructors, and the considerable importance that I attached to them, came and asked me, after the lecture, what it was I was going to talk about.

Several years ago, when I was advising the Vestry of Paddington about the electric lighting of their parish, I found that they were in a serious difficulty in dealing with their ash-bin refuse, and I was led immediately to see the importance of studying the whole question. I then made a personal inspection of most of the destructors which were then in use, and I was so enormously impressed with the importance of the subject that ever since then I have neglected no opportunity of seeing the work which is being done in this direction in the different towns.

Let us see what the problem was that Paddington had to face. Every year they collected something like 20,000 tons of refuse of this character, and since the population of Paddington is 112,000, we may assume generally that something like this proportion exists in nearly all towns. It so happens that the proportion of ash-bin refuse to population does not vary very much with the different towns. Now it will strike you, as it has struck me, as a very wise provision of Nature when I tell you that if that refuse were properly burned, and if it were used in the most economical way, it would be found that (assuming the proportion of lighting required for such population to be, as has been very generally assumed, one lamp per head) the amount of refuse provided by any population is almost exactly as much as is required to supply the illumination by means of the electric light to that same population.

Now let us see what this refuse is which is collected every year in Paddington. Out of every 10,000 tons we find that ashes constitute 5,260 tons, breeze or cinders 2,880, what is known as soft core, viz., animal and vegetable refuse, 1,420, hard core, which is pottery and that sort of stuff, 290, actual coal 15 tons, bones 25 tons, rags 42 tons, iron 35 tons, brass and pewter 3 tons, white glass 7 tons, and black glass 23 tons. Those are the materials that have to be got rid of. I have given you these figures as I found them at Paddington, because Paddington is more able to give accurate information on this subject than almost any place I know of; because in Paddington, instead of simply taking away the refuse and dumping it somewhere or other, as is done in many towns, they found it was more economical to sort out the different materials in this way, and sell some of them for different purposes. They were able to get a sort of price for a great many things. Coal always had its use, and breeze and ashes could be sent to the brickfields, and they were able to recoup themselves to a certain extent, so that really the actual cost of getting rid of it in the parish of Paddington was only about £1,000 per annum. In other places it is very much more, but in any case, the manner of getting rid of it was bad. There was a large proportion of stuff which could not properly be rendered harmless, but which had to be disposed of in some way. The quality of the refuse varies with the different towns. For example, in this you see there is no sludge of the streets, and no other objectionable matter which may be found in other places. In Manchester, for example, out of 10,000 tons there are 6,450 tons of ashes and excreta, which are collected in pails, dust and cinders 3,455 tons, fish and bones 15 tons, dogs, cats, hens, rabbits, &c., 5 tons, boots, rags, hats, paper, &c., 5 tons, vegetable refuse 5 tons, glass, pottery, bricks, &c., 60 tons, old iron and tin-ware 5 tons. That makes the 10,000 tons.

In addition to that, they have to dispose of slaughter-house refuse and market refuse, and street sweepings, amounting to 2,900 tons, in addition to every 10,000. The aggregate quantity of burnable material is 70,000 tons. It is found that the quantity of coal which is collected in the ash-pit refuse varies with different times of the year, and with different districts. It is more in the richer residential districts, and it is also more in winter. In summer there is more vegetable stuff, which is less combustible, and there are some places in which the ashes are exposed to the rain, in which case the combustibility is affected. But then see another wise provision of Nature—the coal and cinders are more frequent in winter, when we want most light, and vegetables are less frequent then, and they are less combustible materials.

The history of the use of destructors is comparatively modern, and the very first ones that were attempted were not very successful. The cause of their failure was almost altogether due to insufficient draught; and in almost all cases where a great improvement has been made in them, it has been by the introduction of greater draught. In the first destructors the furnace was fed from the front, just as the ordinary furnace of a boiler is, but that has been completely done away with now. During the last 20 years, one type of destructor has been most generally used—that is, the type known as Fryer's destructor—which has been made by Messrs. Manlove, Alliott, and Co., of which I shall have more to say later on.

The first destructors which were put up on any scale were in Water-street, Manchester. Eight furnaces were put up, and these were the first that were any practical success. They consumed $28\frac{1}{2}$ tons each per week of $5\frac{1}{2}$ days. They were 8 ft. 6 in. $\times$ 4 ft. 3 in. wide, and 6 ft. 3 in. high from the fire bars up to the crown of the arch; 5 feet of the length was occupied by fire-bars, and 3 feet with the hearth. There was a bridge at the back, and a descending flue down into the main flue for carrying off the gases.

The next place that was furnished with destructors was the Montague-street Wharf, Birmingham. These destructors have been in use for a long time, but they have been combined with the process employed there of converting excreta into profitable manure for agriculturists, and consequently the efficiency of the destructors has been considerably impaired. It was necessary there to keep up steam for the treatment of the excreta, and steam was got up from these furnaces by putting the boilers directly over the furnace. In consequence of this the combustion is very imperfect. The large cooling surface of the boilers impedes the combustion in an effectual degree. In most cases where boilers have been used to generate some steam, the boilers have been put away, and after the gases have passed through the flue they then pass by the boiler, and the error has been in the opposite direction. At Birmingham the fault is placing the boilers on the furnace, so that there is no proper combustion; in many other places, take Southampton, for example, as a notable case, the boilers are put in a place where they cannot benefit from the maximum heat.

After these destructors had been introduced, the Fryer destructor came into more general use. Fig. 1 (p. 903) shows this destructor. The furnaces there are 9 feet long, 5 feet wide, and covered by a fire-brick arch 3 ft. 6 in. high. The furnace has an inclination of 1 in 3, four feet of the bottom being a fire-brick hearth, and the other five feet of fire bars. The furnaces are arranged in two long rows, back to back, with a large flue running underneath and between the rows, as shown in section in the diagram; and the air is admitted beneath the fire bars. At its upper end the furnace is divided in two longitudinally by a short vertical wall. On one side of this division, the hearth is inclined at a greater angle than the rest, as shown in the left-hand furnace on the diagram, and immediately over this is the opening through which the refuse is shovelled down, after being tipped over on the top from the carts which carry it, the hole being shown covered by a flat cover. On the other side of the dividing wall is the opening to a flue leading from the furnace to the main flue, as shown in the right-hand furnace on the diagram. Each furnace then has two outlets at its upper end, side by side, through one of which the refuse is fed from above; the other forming the exit through which the products of combustion pass to the main flue. Besides these, there is, in a few of the furnaces, another hole right over the hottest part of the furnace (shown in the left-hand furnace on the diagram), which is generally covered, but can be opened when required. This hole is usually called the mattress hole, and is used for putting in infected bedding and other material, such as carcases and other slaughter-house refuse, and other such like matters which have to be utterly destroyed. The main flue is sometimes made extremely large, so as to allow dust to settle,

and baffles are sometimes introduced into it to increase the facility of the dust settling. Sometimes at the end of the flue there is a very large chamber put for the same purpose, through which the gases pass before entering the chimney. These are the chief points in connection with the Fryer destructor.

One of the chief defects of this destructor is that it is possible for the air which is admitted to blow towards the flue and carry half-burnt stuff down into the flue. But the danger is not only from half-burnt stuff being carried down, but there is also another serious point, viz., that the fuel which is at the upper end of the furnace is of course being heated up by the flames in the furnace, and consequently giving off injurious and most objectionable gases at that comparatively low temperature, and instead of being burnt in the furnace they may be carried over into the flue immediately with the utmost facility, and become a source of great annoyance to the neighbourhood. In such a type of destructor there are always cases where objectionable and offensive fumes are perceptible, and not only objectionable smells, but unburnt material; consisting generally of a kind of scaly, shiny slag, in minute filaments, is seen to fall in the neighbourhood of the destructor, because this type of furnace does not allow of its being thoroughly burnt. I need hardly say that the higher the temperature in a furnace the better is the destruction of material, and not only is it desirable to have a high temperature, but also to have all the gas passing over that part of the furnace which has the highest temperature.

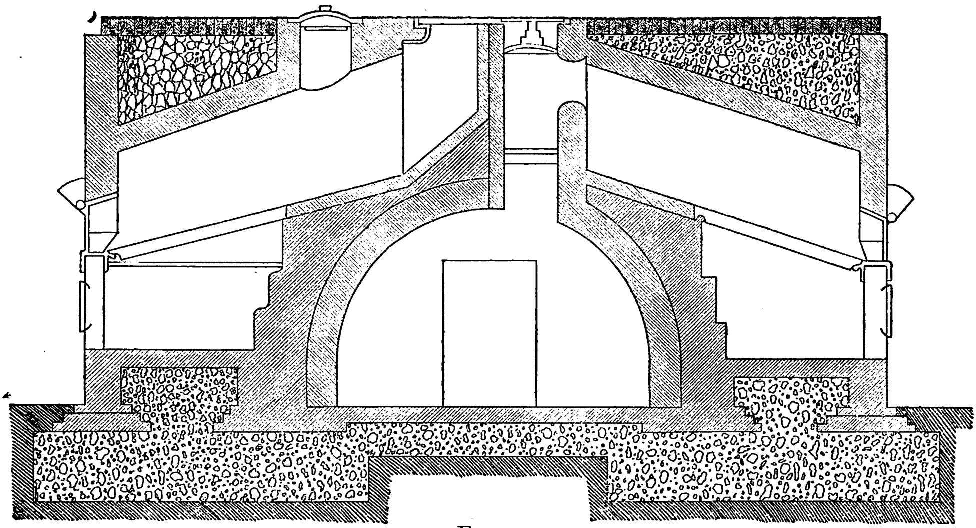


FIG. 1.

I might give a considerable amount of further instruction from the study of many destructors which have been put up, but I will only mention one appliance, which has been built to several destructors, and that is what is called a cremator. It was first introduced by Mr. Chas. Jones at Ealing. It consists of a furnace, in which coal is generally used, and over this furnace all the gases are passed before they go to the chimney, in order to burn the organic matter of the gases which have been allowed to pass through the furnace. I can only say about cremators—although I have seen a great many built—that they are very seldom to be seen at work, except when there is a deputation coming to examine them, because the cost of working them is far too great. If anything in the shape of a cremator were to be used at all, I would suggest that the gases ought to be passed a second time through the furnace, from under the fire bars. Since there is 80 per cent. of air in the gases that come out of the chimney, it is perfectly clear that we could get good combustion in a furnace, if those gases were fed under it.

I will now speak a few words about the best arrangement of destructors which I have ever seen up to the present time, and that is, one of the destructors which are used at Leeds. In 1878, the Corporation began, in an experimental way, with six cells at Burmantofts; in 1879, six more were put up at Armley-road; in 1882, four more cells at each of these places; in 1887, two more cells were put up at Armley-road, and in 1890 they built ten new cells at Kidacre-street. Thus you see Leeds has been

steadily progressing. The first work was purely experimental, but they were thoroughly satisfied with the experiments, and they proceeded to continue the same work. At every step they have seen some improvement which could be introduced, and even at this present moment in connection with what I have just spoken of as the best destructor in existence, they are just going to put down a new destructor, and are going to introduce some totally new improvements. Here again they are going to have experimental work, and see how it does, and if it succeeds, as I think there is little doubt it will, they will proceed to build destructors on the improved plan. In these old destructors some steam was got up to drive a mortar-mill, the clinker being used to make the mortar of, and a considerable amount have they been able to sell. This clinker is always a source of trouble; one-fourth of the weight of the fuel is given back in that form. You cannot be burning iron pots and crockery without getting a certain amount of slag from it; nevertheless, it is found to be the cheapest way simply to put the whole stuff in as it comes from the ash-pits, and burn everything, whether it is combustible or not, if I may use the expression. Consequently there is a large amount of slag, but this slag can be broken up and used for mortar, and it makes admirable mortar. It can also be used for road beds, road foundations, and ballasting, and when powdered and mixed with cement it can be made into artificial stones and paving slabs. The labour at each of these Leeds destructors is one foreman and engine driver, six furnace men, and one labourer. The whole place is perfectly clean, and kept in regular working order. Every pair of cells is charged every twenty-five minutes; they are banked at 1 p.m. on Saturday until midnight on Sunday. The damper to the boiler flue is closed at 7 p.m. on Saturdays. Everything is perfectly methodical. The fuel is carted in up an inclined road over a platform, and tipped upon the platform on the top of the destructor. In the diagram shown here of the Kidacre-street destructor (Fig. 2, p. 906), which I am able to give you through the kindness of the engineer, Mr. Hewson, who has let me have the actual plans which were used in the construction, you will see that half the section shows the furnace, and the other half shows the cell-flue, which is parallel to the furnace and intermediate between every two furnaces. You will recognise some resemblance to the Fryer destructor in this arrangement. The gases, however, before leaving the furnace, pass over the hottest part of the fire, and leave by a hole at the side of the furnace—marked cell-flue in the left-hand section, and also shown in the right-hand section—thence passing along one of the cell-flues into the champion flue, whence they pass on, it may be, by the boilers, it may be by a bye-pass to the chimney. This is the most important improvement that has been introduced by Mr. Hewson. Another great improvement on the old destructors is the addition of a forced draught. Instead of using a blowing engine, as they had plenty of steam in their boilers which they did not want to use in any other way, to avoid having a steam-engine to work, they have driven the steam directly through a jet and through a funnel-shaped aperture (shown underneath the fire bars), the jet of steam drawing air in through it, which passes through the fire bars, and produces a fierce draught, thereby giving very much greater heat, and enabling us to burn a very much greater quantity of material in a given time. I have given you another view here (Fig. 3, p. 907), showing the front elevation of the cells, and showing the general appearance of the place. Here you have the five furnaces which are on one side of the destructor, and there are other five behind these, and the cell-flues in the middle between. The steam coming from the boilers is led to the funnel-shaped inlets for the air, as shown. The fire bars are herring-bone shaped, and are capable of being rocked up and down by means of a handle, thus facilitating the disengagement of the clinker.

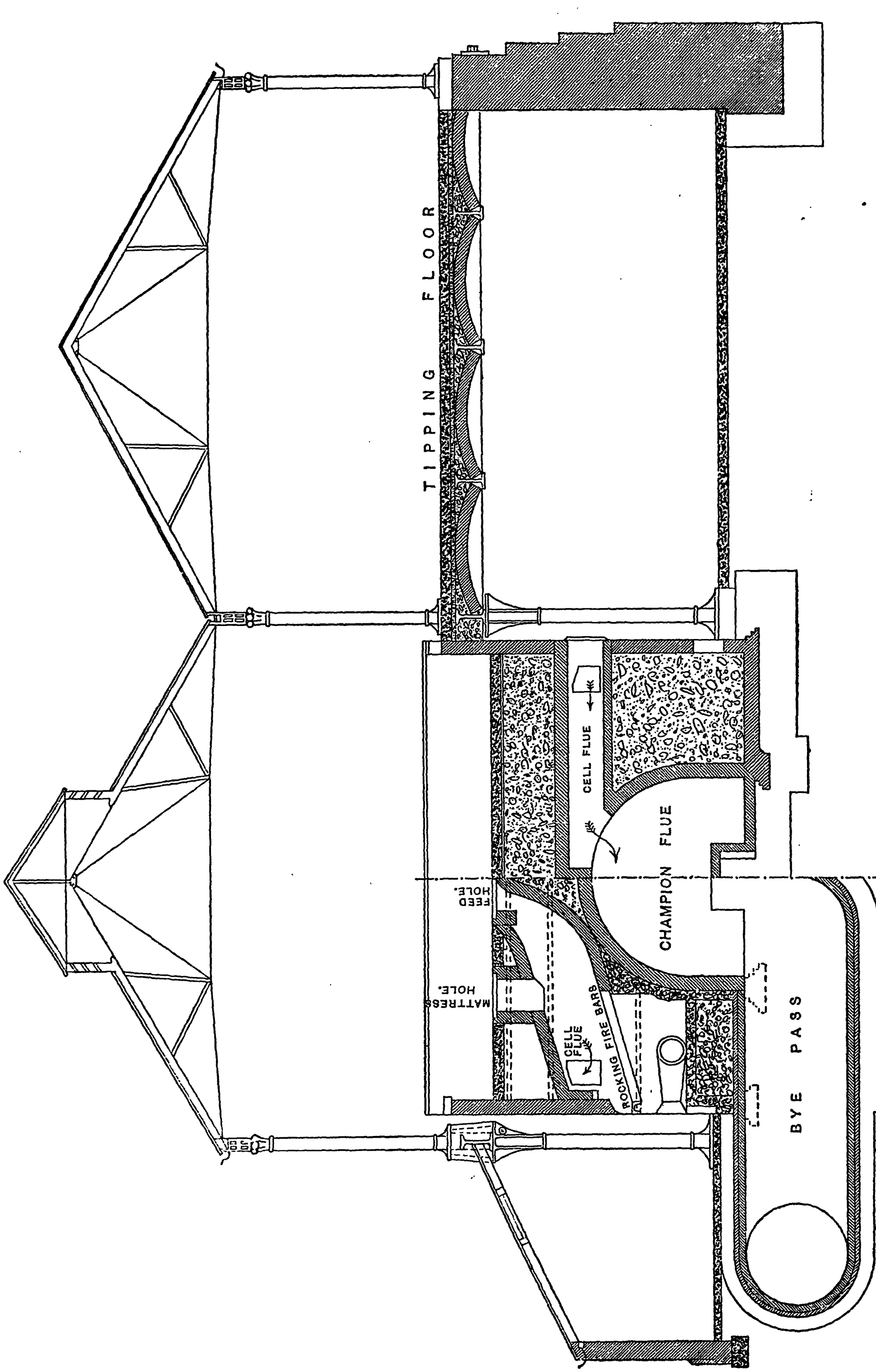
During a single year, up to 1886, that is before the new destructor was built at Leeds, there were 20 cells, which burnt 35,248 tons of refuse. We may generally assume that each furnace is capable of burning about 34 tons a week. The refuse contains ordinary ash-bin refuse along with trade and market refuse. Therefore, in addition to what I have mentioned as being found at Paddington, there was market refuse and other material of that sort, among which I may mention some totally different things. There were 11 cows burnt, 3 calves, 17 sheep, 4 goats, 298 pigs, 5 turkeys, 2 carcases of beef, 28 quarters of beef, 9 cwt. of pork, 10 cwt. of pickled tongues, 12 cwt. herrings, 218 cwt. shell fish, 1 cwt. sugar, 285 dogs, 109 cats, 13 foxes, 1 sea serpent, 147 mattresses, beds, pillows, and bolsters, 7 blankets, quilts, and sheets, 36 pieces of carpet, 7 hearth rugs and mats, 33 pieces of clothing, 1 bedstead, 1 sofa, 1 chair, 1 bundle of rags.

It is something to say that, without any complaint, the destructors at the high temperature at which they work were able to destroy all these objectionable things, which have been found so difficult to get rid of in any other way. The cost of working these furnaces for this one year before the new ones were introduced was:—For wages, £1,162; coal, oil, water, tallow, and gas, £181; implements and repairs, £227; rates, taxes, and insurance, £153; lime, for the mortar making, £78; total cost, £1,801; less mortar and old iron, which was sold, £395; leaving the total cost £1,406. Or, including interest, &c., a cost of 1s. 3d. a ton for destroying refuse. This is less than it would have cost to cart away the material and dump it, besides being, of course, far less objectionable, and the only healthy way of disposing of the refuse. The Leeds destructors, which are going to be put up in the immediate future, have several improvements in the matter of more area; in the matter of washing smoke, to get rid of dust and other objectionable particles that go up the chimney; and the most startling and most efficient idea of automatic feeding. Mr. Hewson tells me he has the intention of having the fire-bars formed in one continuous feeding belt, going along the whole range of the furnaces, the fuel being fed in at one end and carried along over one continuous furnace, being gradually burnt as it travels along. I am sure, judging by the success that Mr. Hewson has had in his past experiments with destructors, what he is going to do now will be very successful; and the smoke washing he has introduced is a plan which has proved to be the most successful mode of getting rid of smoke which has occurred to me.

Various tests have been made of destructors by pyrometers in Leeds. The temperature of the gases at the east end of the furnaces at Burmantofts was over 1,500° Fahr.; at the west end, between the furnaces and the chimney stack, 1,150°; at the bottom of the chimney stack, 875°; the furnaces being fed with air by an arrangement of steam jets, different to that in the new destructor, where they are considerably better arranged than has ever been the case before in the manner I have already described to you, the rapidity of burning being very much greater, and the temperature much higher. Dr. Spottiswoode Cameron, medical officer to the Corporation, has given me valuable information in connection with the destructors. He has gone into these questions of the temperature and analyses of the gases, and he tells me that his experience is that the temperature measured with the pyrometer is very much a function of the observer, but they have had most careful men for measuring these temperatures, and in the new destructor the pyrometers do not read over 1,500°; they are not capable of reading high enough temperatures to read the temperatures in this destructor, so that really during a great portion of the time the temperature is over 1,500°. Mr. Alderman Ward has given some details of some tests which were made with the steam jets, and without the steam jets in this new destructor. The effect was, that while the steam jets were not in action, the average temperature was 1,118°; while the steam jets were in action, the average measured was 1,464°, but in a number of cases the temperature was higher than the 1,500° registered, because the pyrometer would not register more, so that you may be sure that the real average was over 1,500°. Without the jets 6·2 tons were burnt in each cell per day; with the jets 6·7 tons per day. This is a marked improvement over the old experiments made in former times. Mr. Thomas Codrington, who made such an admirable report to the Local Government Board some years ago on furnaces, estimated the average temperature as follows for different places:—In the Whitechapel district, 180° to 1,000°, the average of eight cells being 490°. At Ealing he found 855°, 520°, and 520°. At Bradford, in the main flue, the temperature was 415°. So that there is no doubt that in the Leeds destructor we have a much more valuable result, and it only remains to arrange for generating the steam in a proper manner to get a really good result. The residuary gases have been tested at Burmantofts, and the proportion in every 100 parts is—of air 81·67, carbonic acid 4·0, carbonic oxide 0·16, nitrogen 14·17.

Now, I could have given you a great many more facts about destructors which would have been very interesting, but I think I have said enough to show you that they will play a most enormous part in the industrial lighting of the future, and, at any rate, that the concluding subject of this course of lectures which I have delivered you is one of the most promising lines for engineers to study and develop as far as in them lies.

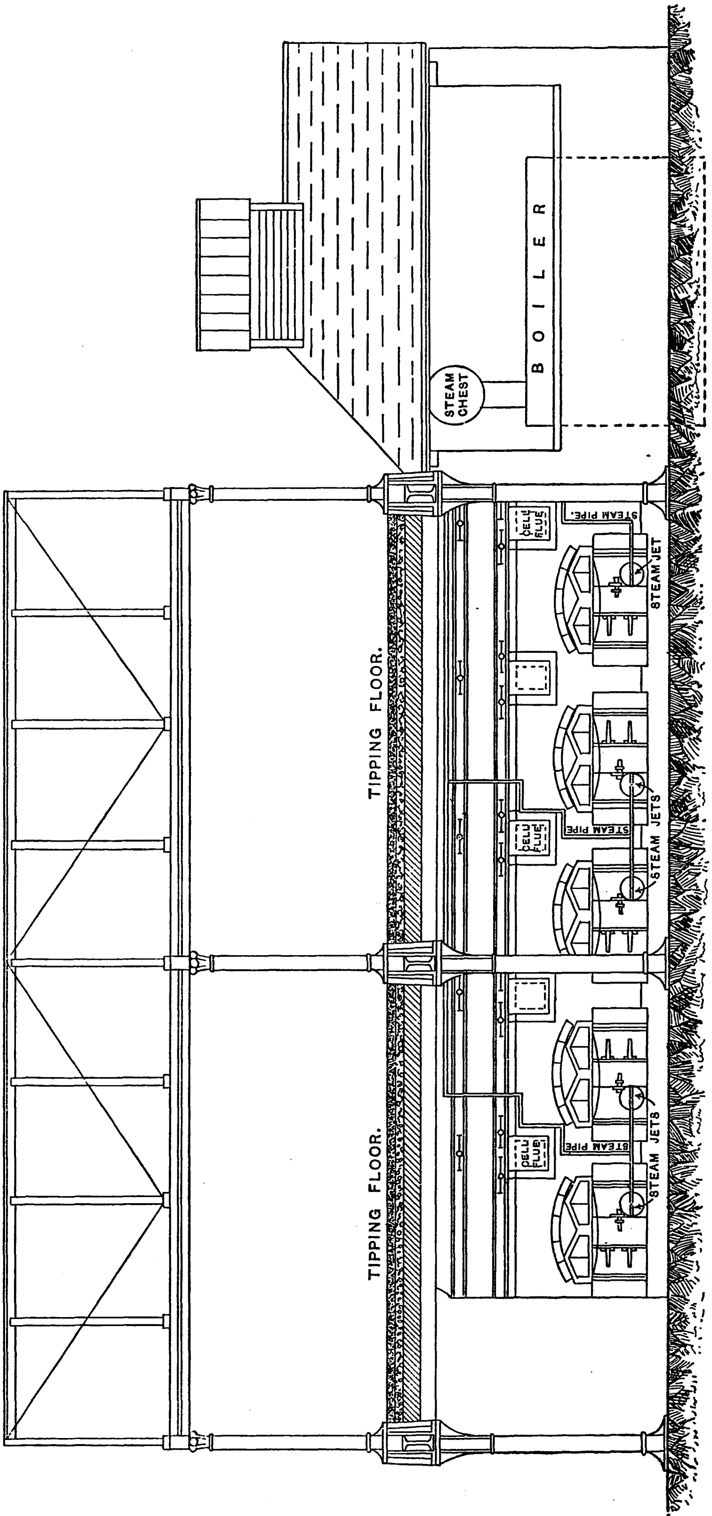
With regard to the other details of the lectures which I have drawn special attention to, I should just wish, in conclusion, to repeat to you one or two points to which I drew



Half Section between Cells.

Half Section through Cells.

FIG 2.



ELEVATION OF FRONT OF CELLS.

FIG. 3.

attention earlier. First, I wish to reiterate the fact that in large central station works on the alternating current system, the plan which must recommend itself to engineers of the present day is to depart from the old plan, and to use low tension secondary mains all over the district that is to be supplied; to have subsidiary stations with large transformers in them, with attendants to regulate them if necessary, or else automatic means of regulating them, so that we may have our machinery always at work at an efficient rate; and last, but by no means least, when we come to work in this way, and to put transformers into sub-stations, that probably the most efficient way will be to use alternations of much lower frequency than anything we have been dreaming of in the past; and for my own part I shall watch with interest to see what manufacturers will do when they see that this is the line on which work must be done. It will be interesting to see whether manufacturers will be ready to supply the machinery required for low frequency when that demand comes, as it undoubtedly must come in the immediate future. Low frequency is not only an advantage because large thick secondary mains can carry currents of low frequency efficiently, while they cannot carry currents of high frequency efficiently, but also because the currents of low frequency will be directly available for motors; and, although I prefer to have motors on a separate circuit, there is no objection to using light motors, never going over one horse-power or so, on the lighting circuits; and for that purpose the low frequency current will supply us with a solution of the problem immediately. We shall also be able to rectify the current, so as to use these slowly-alternating currents, for charging storage batteries, or to perform other electro-chemical operations. For all these purposes, I have no hesitation in saying that that is the best means of modifying the existing practice in connection with alternate current central station work.

With regard to continuous currents, and central station work at low pressures, all I have to say is, that although I cannot see at the present moment that actual economy is introduced by the employment of accumulators in central stations, still they have an enormous convenience, and, if they can be reduced in price, they will be largely used for taking up part of the work at slack times, and also for taking up part of the work during the maximum output. At present, I cannot see that there is any economy in these two things. It is cheaper to generate your current direct, by means of a steam-engine and dynamos, for these two purposes. But the value of accumulators is for regulating the pressure which you are to supply to your feeders; and so enormously important is it that something of that sort must always be used in central stations, that I have only to say that, in the operation, where you do not want to have a very large discharge of current for overcoming a breakdown in your machinery, if you are sufficiently satisfied with your machinery not to expect a breakdown, I would not use then the expensively made up accumulators. I would use nothing but simple plates of lead cut into a definite shape, without putting any oxide into them, or without any previous preparation of the lead, and without paying royalties for any patent rights. I would use the old Planté battery pure and simple, in the cheapest form in which it can be made.

I think these are the only points which I have mentioned in my lectures to which I wished to draw your particular attention, and I hope I may not find that I have made any mistake in drawing attention to these, as points which would deserve very great attention at the present moment.

General Notes.

BELGIAN TELEPHONE SYSTEM.—The State has considerably supplemented the work of the companies constructing and working various small lines, and using on all of th m the double wire (while the companies have mainly continued the single one). The material used is the phosphorus bronze of Montefiore. The subscription varies largely, from 250 fr. in a radius of 3 km. in Brussels and Antwerp, to 125 fr. in Louvain and Malines. One interesting feature of the Belgium lines is that they are all connected with the principal telegraph offices, so that subscribers can send to these, by telephone, any telegrams they wish sent, and similarly they can receive telephonically any telegrams addressed to them. A copy of the telegram is sent at the same time. The number of telegrams thus sent by telephone in 1889 was 371,000; in 1890 it grew to 440,000. To facilitate the development of telephonic relations the country is divided by Government into a number of circles, containing several towns provided with central offices communicating with each other by means of a double wire. Thus the inhabitants of a small town like Heyst are able to speak with Bruges, Blankenburgh, Ostend, Middlekerke, and Nieuport.—*Nature.*

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

DEDICATORY CEREMONIES.

The dates for these ceremonies are the 19th, 20th, and 21st October. The following programme for the final, or actual Dedication Day, has been issued by the Council of Administration and the Committee on Ceremonies :—

The National salute, at sunrise, October 21, will inaugurate the ceremonies of Dedication Day. The President of the United States, ex-Presidents, members of the Cabinet, members of the Supreme Court, members of the Senate and House of Representatives, distinguished foreign guests and Governors of the different States and territories, with their official staffs, will be escorted by a guard of honour, composed of troops of the United States army, detachments of the United States naval forces, and regiments from the various State and National Guards, to the Manufactures and Liberal Arts Building, in which the dedication ceremonies will be held.

At 12.30 o'clock in the afternoon, in this building, the dedicatory exercises will be conducted, under the direction of the Director-General, as master of the ceremonies, according to the following programme :—

1. "Columbian March," written for the occasion by Professor John K. Paine.
2. Prayer, by Bishop Charles H. Fowler, D.D., LL.D., of California.
3. Introductory address by the Director-General, as master of ceremonies.
4. Address of welcome and tender of freedom of the City of Chicago, by the Hon. Hempstead Washburne, Mayor.
5. Dedicatory ode; words by Miss Harriet Monroe, of Chicago, from which selections will be read; music by G. W. Chadwick, of Boston. This production is a tribute to woman's work, and introduced in recognition of the Board of Lady Managers.
6. Presentation of the master artists of the Exposition to the President of the World's Columbian Exposition by the Director-General of Works, and the award to them of appropriate medals, commemorative of their completed woik, by the President of the United States.
7. Chorus, "The Heavens are Telling."
8. Presentation of the buildings for dedication by the President of the World's Columbian Exposition to the President of the World's Columbian Commission.
9. Presentation of the buildings on behalf of the World's Columbian Commission by the President thereof to the President of the United States for dedication.
10. Dedication of the buildings by the President of the United States.
11. "Hallelujah Chorus," from "The Messiah" (Handel).
12. Dedicatory oration, the Hon. William C. P. Breckinridge, of Kentucky.
13. "Star Spangled Banner" and "Hail Columbia," with full chorus and orchestral accompaniment.
14. Columbian oration, the Hon. Chauncey M. Depew, of New York.
15. Chorus, "In Praise of God" (Beethoven).
16. Prayer, by the Most Rev. John Ireland, Archbishop of St. Paul.
17. Benediction, the Rev. Dr. McCook, of Philadelphia.
18. National salute.

In the evening a special electric and pyrotechnic display will be given on the Exposition grounds appropriate to the occasion.

LIVE STOCK EXHIBITION.

Since the publication of the Regulations relating to the Exhibition of Live Stock in the *Journal* for July 15th last (see *ante* p. 797), further arrangements have been made, and the following regulations have just been issued :—

The Exhibition will be held from June 12th to October 28th, 1893.

The dates for different divisions are as follows :—

A. Cattle, and B. Horses, Jacks, Jennets, and Mules ..	Aug. 21 to Sept. 21.
C. Sheep. D. Swine..	Sept. 25 to Oct. 14. (Entries close July 1.)

E. Dogs ....June 12 to 17.
(Entries close May 20.)

F. Poultry, Pigeons, and Pet Stock. G. Fat Stock .... } Oct. 16 to 28.
(Entries close in F., July 15, in G., August 1.)

In divisions A. B. C. D. G. only two entries are allowed in each section. Animals will be subject to the quarantine regulations, and must be on the ground by the opening day for division, but can be sent three days before.

Applications (to be made with the sanction of the Commission) must show, except in divisions E. F. G., as otherwise stated, 60 days ownership, name, age (to be computed up to September 11th for cattle; horses, August 24th; sheep and swine, October 2nd; dogs, June 12; fat stock, October 16), sex, description, and registration in one of the herd, stud, or stock books to be set out, or that the animal is of a recognised breed for which no established record exists. In the case of 5-year stallions and mares, and 4-year bulls and cows, or 3-year rams and ewes, and 2-year boars and sows, evidence will be required of siring or producing, within two years immediately preceding August 21 or September 25 respectively.

The Departmental Chief can form additional classes, exclude any animal not a typical representative, or remove any that are vicious or fractious. Accommodation will be provided, but the exhibitor must keep the same in proper order, and provide attendants. A veterinary surgeon will examine animals before admission, and inspect and report daily, and sick animals will be removed to a separate enclosure. Facilities will be provided for distribution of water, and forage, grain, and bedding will be furnished at reasonable prices from depôts within the grounds.

In divisions A. B. C. D. G. all animals will be placed in each section in order of relative superiority, and premiums paid in accordance with such numbering, *i.e.*, 1st, 2nd, 3rd, 4th (in the event of expulsion or disqualification after numbering, the subsequent numbers to be correspondingly advanced). The Jury may call for satisfactory proof, in writing, of any fact (save age, to be referred to a veterinary surgeon) required in connection with entry.

Protests must be in writing, and filed before the close of the period assigned to the division to which the protested animal belongs. In the event of death or injury of any animal (for which the Exposition will not be responsible), the chief of the department may authorise the substitution of another animal, in all respects eligible at date of original application. Right is reserved to add to, interpret, change, or amend the rules, as the interest of the Exposition may demand.

A. The premium list contains 14 classes of 15 sections each. Firsts, by age, single, $40 and $50; herd or collection, $75, $80, and $100; cow and two of her produce, $40 and $50; bull or cow, any age per class, medal and $50. Sweepstakes (6), herd: firsts, $350 and $500, and two of $200 and $350 each; and 27 by age, limited to 1st and 2nd prize winners, medal and $25.

B. The premium list contains 16 classes of 14 sections each. Firsts, by age single, $60, $75, $110, and $150; stallion or mare and colts, $150 and $200 (medal only in Morgans), and any age or collection per class, three medals; 2 of 14 sections, with medals and diplomas; 2 of 6 sections for horses to be shown under saddle and Shetland ponies, firsts, $110 and $100 respectively, and any age medals; and special class for mules, firsts, single $50, $100, pairs $150.

C. The premium list contains 13 sheep classes of 11 sections each. Firsts, by age single, $25 and $35, ram and ewes $30 and $40, pens $35 and $45, any age ram or ewe per class $50; and 2 goat classes of 7 sections each (only 1st and 2nd), firsts, by age single, $15 and $25, pens $30, any age buck or doe per class $40.

D. The premium list contains 9 classes of 8 sections each for single animals, 6 for collections. Firsts, former $20, $25, $40, and $50, latter $40 and $85; sweepstakes, boars or sows any age (4 per class), $35, $50, $75, and $100.

E. Entries must clearly identify the dog to be the *bonâ-fide* property of the exhibitor on or before May 1, giving date of birth, sire and dam, and name of breeder, and $1·50 must be remitted to cover cost of bench, feed, and care. Each dog must be passed upon by the veterinary before being benched. Juries (appeals from which will only be entertained where misrepresentation or breach of rules are charged) may disqualify any thought improperly tampered with, subject to veterinary's decision (if not sustained, class to be re-judged), and withhold prizes or medals for want of merit. Where weight is limited, the exhibitor, upon written request to departmental chief, can have weight of dog taken and registered. The premium list contains 42 classes, in 21 of which there is

a champion class, with medals. Firsts, \$20, \$24, \$30, and \$40; seconds, \$10, \$15, and \$20; thirds, diploma.

F. Poultry will be admitted under rules governing admission at competitions in England. Coops provided, and ·25¢ per bird to be paid for care and feeding. A committee will examine entries, and return sick or inferior birds.

G. The premium list contains for cattle 8 classes, 3 sections, first, \$35, second \$25, third \$10, and \$50 sweepstakes per class; sweepstakes, 3 of \$50, 1 of \$100; herds, 8 of \$50, 1 of \$200; for sheep, 11 classes, each 4 sections, first and second, firsts \$12 and \$17, and class sweepstakes, diploma; 2 sweepstakes of \$25 and diploma, and the grand sweepstakes \$75 and diploma; for swine, 10 classes, 4 sections, firsts and seconds, firsts \$20 and \$25; pen and breeders sweepstakes, firsts \$50 and \$75, seconds \$40 and \$50.

In addition to the foregoing, there are special premiums offered by associations and individuals.

WATER ROUTE TO CHICAGO.

The following information regarding waterways to Chicago will be interesting to any yacht-owner who may be contemplating a visit to the Exhibition next year:—

The route, *viâ* Canada, is up the St. Lawrence, ascending the river to Montreal. Then comes the Lachine system of canals, whose present capacity will not permit the transit of vessels of more than nine feet draught. The improvements on them—in progress—will not be completed before the conclusion of the World's Fair. The route from Montreal is through the Lachine Canal (8½ miles), five locks, depth of water on sills, 9 to 10 feet; Lake St. Louis (15⅝ miles); the Beauharnais Canal (11¼ miles), nine locks, depth of water, 9 feet; Lake St. Francis, (32⅝ miles); the Cornwall Canal (11½ miles), six locks, depth of water, 9 feet; Farran's Point Canal (three-quarters mile), one lock, depth of water, 9 feet; Rapids Flat Canal (4 miles), two locks, depth of water 9 feet; Gallop's Canal (7⅝ miles), three locks, depth of water, 9 feet; and, after Lake Ontario, the Welland Canal (27½ miles), 27 locks, depth of water, 14 feet, to Lake Erie. Thence, *viâ* Detroit River, Lake St. Clair, St. Clair River, Lake Huron, and Mackinac Straits to Lake Michigan, on which there is plain sailing in navigable waters to Chicago.

Vessels of greater draught have passed the canals by using pontoons and "camels." The Collins Bay Rafting and Forwarding Company, Collins Bay, Ontario, Canada, will furnish appliances and contract for the lifting of vessels through from Montreal to Lake Ontario and through the Welland Canal, if desired. The official tax for passage through the St. Lawrence and Welland Canals, from Montreal to Lake Erie, is 2¼ cents per ton register. This is levied upon yachts as well as other vessels.

Very full information as to methods of reaching Chicago by water was given in two articles which appeared in the *Field* newspaper, September 3rd and 10th. The first of these dealt with the Canadian route, the second with routes from New York *viâ* the Hudson River and Erie Canal, and from New Orleans *viâ* the Mississippi and Illinois rivers.

Proceedings of the Society.

CANTOR LECTURES.

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By Percy F. Frankland,

Ph.D., B.Sc.(Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

Lecture I.—Delivered May 2, 1892.

Although the fermentation industries are amongst the most ancient and venerable of all the arts and manufactures which have engaged the attention of the human race, they are precisely those which have had to wait longest before being placed on a sound scientific basis. Of incalculably greater antiquity than such industries as the manufacture of acid and alkali, of glass, or of artificial colours, all of these have undergone a much more rapid development as regards the perfecting of the processes involved, through the light of scientific knowledge, than has been the case in the fermentation industries, in which, until recently, many of the operations were shrouded almost in the same darkness that enveloped them thousands of years before the commencement of the Christian era.

The cause of this more tardy development is not far to seek; it is obviously due to the fact that, whilst the ordinary chemical industries depend upon chemical and physical changes in comparatively simple substances, the fermentation industries owe their existence to those far more subtle changes which are realisable through the intervention of what we now generally call "living protoplasm," which

was, until long after the beginning of this century, believed to be subject to entirely different laws from those governing the inanimate creation, and to be capable of bringing about changes through the mysterious agency known as "vital force."

But, although the first great wave of scientific discovery in the domain of organic chemistry, which marked the second quarter of the present century, succeeded in demolishing this phantom of Vital Force, by showing that substances which were only found in nature as the products of animal or vegetable life could also be produced artificially in the aboratory, yet, owing to the great complexity of most of these vital products, and the great experimental difficulties which generally attend their investigation, it is only natural that the progress of our knowledge concerning them should have been comparatively slow.

Thus, notwithstanding that one of the simplest—although most important—of these vital products, *urea*, was first artificially obtained already in the year 1832 by Wöhler, it is only within the last few years that even vital products of such comparative simplicity as the sugars have been artificially obtained by Emil Fischer, who has been assisted in their production by the practical experience and theoretical speculations of 50 years of unparalleled activity in every department of science.

It is sufficiently evident, therefore, that the accurate study of vital products is attended with great difficulties, and moves forward but slowly; and, on these grounds, we should anticipate that scientific progress in connection with the fermentation industries would be slow also. But there is a further difficulty attaching to their study, for the living organisms upon the vital activity of which these industries depend are so minute that their careful investigation has had to wait for the development of an elaborate technique which it has taken years and the ingenuity of numerous gifted experimenters to perfect. Thus microscopes of great power and special construction have had to be devised in order to render them distinctly visible, but owing to the only very slight differences in appearance which are exhibited by many of these minute organisms when viewed under the most powerful lenses, mere microscopic examination has proved quite inadequate to distinguish between them in most cases, so that supplementary study by culture, that is to say, by growing them in suitable media, has during recent years been more and more resorted to.

This study by culture, again, is attended with great difficulties, because, owing to the almost universal distribution of these minute organisms in all our surroundings, there is the continual danger of the forms we wish to study becoming mixed or contaminated with other forms accidentally introduced. Now, it is just in this direction of obtaining and maintaining what are known as pure cultures that such great strides have been made in recent years, and which have enabled the study of these minute forms of life to be prosecuted with accuracy and precision.

The operations connected with the study of these micro-organisms are of such a specialised character that this study may conveniently be regarded as a separate science in itself, to which we now generally give the name of bacteriology, although, of course, it really consists in the application of numerous sciences, such as physics, chemistry, botany, &c., to the study of the phenomena exhibited by these microscopic forms of life.

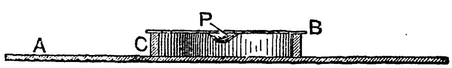
We will endeavour, in this first lecture, to make ourselves acquainted with some of the more important methods of study which have yielded such abundant fruit during recent years in all departments of bacteriology.

Microscopic Examination.

The older methods of examining a material for micro-organisms consisted in simply transferring some to a clean cover-glass, mixing, if necessary, with a little water, and then examining under a high power of the microscope. In this way the organisms can be seen in the living state, but owing to evaporation from the edge of the cover-glass, disturbing currents in the liquid are produced, whilst the whole soon becomes dried up, and further observation is thus rendered impossible.

In order to obviate these disadvantages, and especially to render observation in the natural and living state possible over hours, days, or even weeks, the device has been resorted to of cultivating in a suspended drop of nutritive liquid.

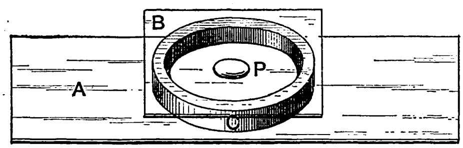
Fig. 1.



Suspended Drop Culture.

A Glass slide. B Cover glass. C Glass ring forming the wall of the chamber. P Drop of nourishing material in which the micro-organisms grow.

FIG. 1A.



SUSPENDED DROP CULTURE.

A Glass slide. B Cover glass. C Glass ring forming the wall of the chamber. P Drop of nourishing material in which the micro-organisms grow (after Klein).

In this manner the complete life-history of a micro-organism, from its cradle to the grave, can be watched. Seen under these circumstances some micro-organisms are found to be possessed of mobility whilst others are stationary. Again in this way the marvellous rapidity

FIG. 2.

BACILLUS SUBTILIS, SHOWING TRANSVERSE DIVISION. (After Klein).

of multiplication exhibited by some micro-organisms has been determined; thus in the case of one bacillus it has been found that division into two takes place in as little as 20 minutes.

STAINING OF BACTERIA.

The great advances which have been made in our knowledge of micro-organisms within recent years are largely due to the methods which have been devised for accentuating their appearance by means of brilliant colours. Striking colours are employed by both the savage and the civilised man, or rather woman, to render themselves more conspicuous, in the latter case by clothing in coloured garments, whilst by the savage the process of brilliantly colouring the body itself is adopted. Now this is also the process employed by bacteriologists to render micro-organisms conspicuous amongst their surroundings. The bodies of these micro-organisms are dyed, and the dyeing is carried out on the same principles as the dyeing of a skein of silk or a hank of wool.

These textile fibres, silk and wool, as is well known to dyers, are most readily coloured by what are called the basic colouring matters, to which group belong the brilliant aniline dyes, like magenta, methyl violet, malachite green, &c. The great advantage of these dyes consists in the rapidity and intensity with which they colour the materials for which they have an affinity.

It must not be supposed that all materials have an affinity for or can be dyed by these basic aniline colours, and the following experiment will serve to show how their affinity for the substances of which micro-organisms are composed enables these to be distinguished amongst their surroundings.

[Experiment.—Dyeing of silk and wool, which have been stitched through piece of calico, by immersion in dilute solution of magenta; on subsequent washing with water, the colour is removed from the calico (cotton), whilst the silk and wool remain permanently coloured.]

In most cases, however, the staining of micro-organisms is not such a simple matter as this, for the bodies with which they are surrounded have also generally a strong affinity for these basic colours, which results in these bodies becoming also dyed with the colour employed.

There is, however, a peculiarity about these micro-organisms which enables us to strongly dye them whilst leaving the surrounding matters colourless or only faintly tinged. The micro-organisms in fact appear to be invested with an envelope which offers great obstacles to the penetration of the colouring matter to their interior. This envelope of the micro-organisms, however, serves to protect them from influences which readily affect bodies not so surrounded, and it is this circumstance which is taken advantage of in various ways in the dyeing or staining of micro-organisms. Thus one of the simplest and most commonly practised expedients consists in exposing the micro-organisms and the materials with which they are mixed to such a temperature that whilst the other materials are so scorched by the heat that they are no longer capable of being dyed, the micro-organisms wrapped in their protecting blanket, so to speak, suffer, prac-

tically, no injury. On now applying the dye to the scorched specimen, the micro-organisms become strongly and permanently coloured, whilst the surrounding matters remain colourless.

You might think that it was very difficult to apply heat so delicately adjusted as to injure these other materials without affecting the micro-organisms, but as a matter of fact, with a little experience it can be done with great readiness and facility.

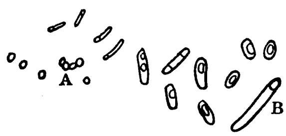
[Demonstration of preparation of scorched cover-glass with subsequent dyeing.]

In this manner, or by subsequently removing the dye from the surrounding materials by means of acids, the most beautiful microscopic preparations of micro-organisms can be obtained. Some idea of the appearance of these I can convey to you by means of the following coloured slides and diagrams.

[Demonstration of slides and diagrams of stained micro-organisms:—Spirilla of Asiatic cholera, typhoid bacilli, micrococci of erysipelas, yeast, &c.]

The examination of the stained micro-organisms, dyed as I have described, sometimes reveals the presence within the micro-organisms of small round or oval bodies which have not taken up the colouring matter. These bodies, shown in the following figures,

FIG. 3.



A.—SPORES MAGNIFIED 700 TIMES.
B.—SPORES AND BACILLI CONTAINING SPORES MAGNIFIED 1,650 TIMES.

are the so-called spores, which in consequence of their great power of resisting destruction are of such tremendous importance in the propagation of some micro-organisms.

Although sufficiently conspicuous by the fact of their not sharing in the gay colours which have been bestowed on the micro-organisms themselves, bacteriological artists are, nevertheless, fond of painting them also, which can be done by a little modification of the process I have described. To this end the preparation containing spores is dyed not with an aqueous solution of one of the basic colouring matters, but with a solution of the colouring matter in aniline water, which gives the dye a greater power of penetration. In this manner even the spores become dyed, and *à fortiori* the fully developed micro-organisms also. The colouring matter having penetrated into the interior of the spores, is there much more firmly fixed than elsewhere in the preparation, so that if we now submit the latter to a decolourising process by a submersion in dilute nitric acid (1 : 3), the colour will be last removed from the spores.

[Demonstration of decoloration of magenta by dilute nitric acid (1 : 10)].

Having then removed the colour by means of dilute acid from everything excepting the spores, we proceed to re-dye the fully developed micro-organisms by means of another colour in the ordinary way. In this manner a beautiful and most effective microscopic preparation is obtained, in which the spores are tinted with one colour, and the fully developed organisms with another, as in the following slide:—

[Demonstration of *Bacillus subtilis*, with spores stained in one colour and the bacilli in another.]

It is a highly remarkable phenomenon, that some fully formed micro-organisms offer the same difficulties in the way of being stained as do the spores. This is notably the case with one of the most important of all the micro-organisms with which we are acquainted, viz., the tubercle bacillus. The great value of detecting this bacillus for clinical purposes has led to a number of methods being devised for rendering them apparent through staining. These methods are based on essentially the same principles as those which I have described for the staining of spores.

[Demonstration of slide of tubercle bacilli in giant cell, the bacilli stained with methylene blue, the nuclei of the giant cell with Bismark brown.]

The refinements of microscopic *technique*, in connection with micro-organisms, have, however, gone even beyond what I have yet described; for none of the methods of staining already mentioned are successful in displaying certain highly important structures possessed by some forms, viz., the organs of locomotion, by means of which some, at least, of the motile microbes are able to propel themselves about in liquid media, often with fabulous rapidity. These organs of locomotion, unlike either the bodies or the spores of micro-organisms, have no affinity for these aniline colours, which we have seen are so useful in exhibiting the latter. In the practice of dyeing textile fibres we are also acquainted with

fibres which exhibit the same indifference to these colours; thus, cotton and linen cannot be directly dyed with the basic aniline colours, and, in order to dye them with these colours, we have, in the first instance, to prepare these fibres, by impregnating them with what are known as mordants.

[Experiment.—Cotton not dyed by solution of magenta, but cotton previously mordanted with tannin, takes the dye readily and permanently.]

Now, this is essentially the principle on which it has been found possible to demonstrate in the most beautiful way the existence of organs of locomotion in the case of motile micro-organisms.

FIG. 4.

TYPHOID BACILLI, SHOWING THE FLAGELLA, OR ORGANS OF LOCOMOTION. (After Migula.)

It will thus be seen that we are now provided with numerous appliances for carefully studying the form of micro-organisms. Indeed, with the best modern microscopes, and by carefully staining, their outlines are so sharply distinguishable, that the most beautiful photographic representations of these minute forms of life are obtainable.

CULTIVATION OF MICRO-ORGANISMS.

Although great strides have been made in the methods of examining micro-organisms microscopically, these improvements are really of far less importance than those which have been introduced in the study of these organisms by growth, or culture, as it is termed.

The cultivation of micro-organisms has become a matter of such many-sided interest and consequence, that it is impossible to discuss any questions connected with fermentation and other processes in which micro-organisms are concerned without a knowledge of the principal methods which are employed in their cultivation. We shall, therefore, be obliged to speak of these in some detail.

For the cultivation of all micro-organisms, more or less moist materials are necessary, both liquids and solids being employed for the purpose. It might be supposed that it would be easy to find a medium which would suit the requirements of all micro-organisms, since, from some points of view, they are all so similar; but, as a matter of fact, there is the greatest diversity in their tastes, and media which are suitable for the growth of some are utterly unfitted for the cultivation of others. Thus, whilst some organisms are unable to thrive and multiply excepting when surrounded with the most nutritious and subtle foodstuffs, others absolutely refuse to grow unless bathed in a liquid from which such organic materials have been most carefully banished. The ingenuity of the bacteriologist is, in fact, severely tried in endeavouring to cater for the organisms which he has under his charge, and every year, or even month, sees many additions to the *menu* from which he has to select, and which already includes such a medley as living animals, blood serum, bouillon, beef jelly, agar-agar, potatoes, bread, malt-wort, numerous purely mineral solutions, &c.

Whatever medium we may be employing, it is, before all things, necessary that it should be deprived of every form of living matter, so that only those organisms which we purposely introduce may be nourished and fostered. In the language of bacteriologists, the medium must be sterilised. This sterilisation may be effected in various ways.

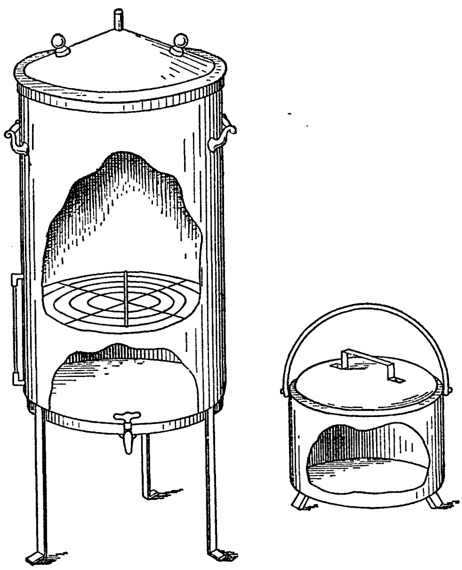
1. The medium may be naturally sterile or devoid of living matter, and in this case we have only to prevent the accidental introduction of living germs during manipulation. This is notably the case with blood serum; the blood of healthy animals is free from micro-organisms, and if, before inflicting a wound, the surface of the body be disinfected, and the blood carefully collected in sterile vessels, it will remain sterile, and the serum which separates can be further transferred to sterile vessels, which, if adequately protected from the access of living germs, will remain sterile and unchanged for an indefinite period of time.

2. More commonly we employ the agency of heat to effect the destruction of the living organisms which may be accidentally present in our culture-media; the most convenient mode of applying the heat being by means of steam, as can be done in the piece of apparatus represented in Fig. 5, p. 916, and which is generally termed a steam steriliser.

In order that this steaming may be certainly effectual, it is necessary that it should be continued for from half to one hour, which would seriously impair the qualities of some of the culture-media we employ.

This difficulty is overcome by means of what is called discontinuous or fractional sterilisation. It is found, in fact, that if a medium is repeatedly steamed on several days for a few minutes each day, it is as effectually sterilised as if it had been continuously steamed on one occasion for a long period of time. This phenomenon is generally explained on the assumption that the few minutes' steaming kills all organisms excepting spores, and that by allowing a day to intervene between the first steaming and the second, an opportunity is given to these spores to germinate, so that at the second steaming the fully developed organisms, to which the spores have thus given rise, will be killed also. A third steaming is

FIG. 5.



STEAM STERILISER

generally superadded to insure the process of destruction being completed. It is, however, in my opinion, far more probable that the effectiveness of the discontinuous application of heat depends upon the destructive action of the temperature being rapidly raised to the boiling point, and that the repeated raising of the temperature is far more fatal than if the high temperature is merely maintained over the same period of time. This discontinuous steaming is particularly necessary for the sterilisation of nutritive media containing gelatine, as prolonged steaming greatly reduces the melting point of the gelatine.

3. Discontinuous or fractional heating may be made a means of effectual sterilisation, even without employing a temperature as high as that of boiling water. Thus milk should be sterilised by heating it on four or five successive days for one hour on each day to 65-70° C. or 150-160° F., for in so doing the chemical character of the milk is not changed, as at this temperature the albumen is not coagulated as would be the case if it were heated above 75° C. or 167° F. This fractional sterilisation, which was originally devised by Tyndall, is one of the most important points in practical bacteriology.

The importance of the sterilisation of milk has become so manifest, that on the Continent it is now sometimes actually carried out on an industrial scale, and numerous forms of apparatus have been devised for effecting it.

The difficulty of preserving milk is equally felt by both dairyman and consumer; and the former frequently resorts to chemical additions of a very doubtful character to secure this end. The additions most commonly made are carbonate of soda and borax, the former having the effect of neutralising the lactic acid, which causes the souring and curdling of milk, whilst the borax exerts an antiseptic action, and thus prevents the growth and multiplication of micro-organisms, which bring about changes in the milk.

Far preferable is the preservation of milk through heat, for in this way also pathogenic organisms, which are liable to be present at any time in this excellent culture medium, are also destroyed. In Germany this industrial sterilisation of milk has been carried on for some years, by means of Thiel's apparatus, in which the milk is passed over a heated corrugated metallic surface which rapidly raises its temperature to 75-85° C., after which it is promptly cooled down to 10-12° C., by means of a refrigerator. More recently, Soxhlet has devised a method of preparing milk—more especially for infants—by heating in separate flasks to upwards of 75° C.; the flasks are then tightly corked, the heat being maintained a little longer, after which they are cooled. The milk thus treated is not necessarily or generally sterilised, for milk often contains just those microbes which are most difficult to destroy, and which have gained access from hay dust or the like. Owing, however, to the greater number of the microbes having been killed, it keeps better, and, most important of all, the pathogenic organisms will have been destroyed with almost perfect certainty. The importance of this latter point is sufficiently evident, without considering the

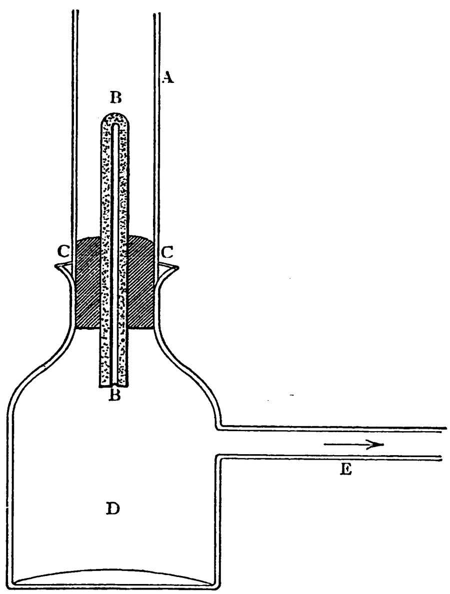
occasional communication of the ordinary zymotic diseases through milk, when we bear in mind the frequency of tuberculosis amongst cows. Thus, in the slaughterhouses of Silesia, it has been found that the following proportions of the cattle are affected by tuberculosis :—

Calves	·13	per cent.
Bulls	1·00	,,
Young beasts	1·87	,,
Oxen	7·31	,,
Cows	9·54	,,

Although it is highly desirable that such a sterilised milk industry should be established in this country, it is undoubtedly a still more satisfactory safeguard for the consumer himself to submit the milk to boiling before use.

4. After this digression we pass to another method of sterilisation, which has recently become of very great service where the application of heat is inadmissible, and which consists in filtration through porous porcelain under pressure, as shown in the following figure :—

FIG. 6.



PORCELAIN OR CHAMBERLAND FILTER.

A Glass cylinder in which the liquid to be filtered is placed. BB Porous porcelain hollow cylinder, passing tightly through india-rubber stopper (CC), which also fits the strong glass bottle (D) into which the filtrate passes, and in which a partial vacuum can be produced by connecting the side-tube (E) with a pump.

This method is of course only available in the case of liquids, and is of special value in the investigation of the products generated by micro-organisms, in which it is desired to separate the products from the organisms, as many of these products are destroyed or altered by high temperatures.

It is by the use of this arrangement that the various soluble ferments frequently generated by micro-organisms have been isolated, and it has been of special service in separating pathogenic organisms from the soluble toxic substances to which they often give rise during their growth.

Miscellaneous.

THE ELIHU THOMSON PRIZE.

At the last prize contest instituted by the City of Paris for the best electric meter, the prize of 5,000 francs was awarded to Prof. Elihu Thomson. With the desire that this sum should serve for the development of the theoretical knowledge of electricity, he has arranged that it shall be devoted to form a prize for the best work on a theoretical question in electricity.

The following gentlemen have undertaken to act as members of a committee to award the prize :— J. Carpentier, President of the Société International des Electriciens; Hippolyte Fontaine, Professor E. Hospitalier, E. Mascart, A. Potier, B. Abdank-Abakanowicz, Secretary.

The committee has decided that the prize should be given for an investigation on one of the following subjects :—

1. The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dielectric, and quantity of charge.

2. It has been shown, theoretically, that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents, as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally, under such conditions that the exact measure of resistance, capacity, and co-efficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula.

3. When a condenser, made with an imperfect insulating material, has been charged, and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not

present themselves in metallic conductors, and whether these can be shown experimentally.

4. It is proposed to arrange and systematise our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods, as in graphical statics.

The essays presented may be written in any one of the following languages:—English, French, German, Italian, Spanish, or Latin. They may be in manuscript or printed.

Each essay must be signed by a pseudonym, and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside.

The papers must be sent before the 15th September, 1893, to B. Abdank-Abakanowicz, Consulting Engineer, the Secretary of the Committee, at 7, Rue du Louvre, Paris, who will furnish any further information required.

THE TRADE OF CHICAGO.

In his last Consular Report on Trade and Commerce of Chicago for 1891, Colonel Sadler furnishes much information likely to be of value to those interested in the Chicago Exhibition, either as exhibitors or visitors.

The record for 1891 shows continued increase in trade and commerce, and the bulk of business has exceeded that of any previous period, the past season being distinguished by the largest return of cereals ever produced in this region. The total trade of Chicago in 1891 is estimated at £300,825,000, against £284,500,000 in the preceding year, or a little less than one-third of the total bank clearings. This includes the produce, wholesale, and manufacturing trades, only such transactions in produce as have been followed by delivery from producer to consumer, and is calculated on the first selling value of all goods arrived, except the precious metals, with the additional value that they may have acquired by local manufacture. The great increase of $17\frac{1}{2}$ per cent. made in the volume of trade in 1890 has been maintained, and a further increase of about 5·7 per cent. has been made. The principal feature of the produce trade was the large increase in the receipts and shipments of wheat. Rye arrived in larger quantities, while there was a falling-off in corn and barley. There was a large decrease in the receipts of cured meat and lard. Prices were not subject to many fluctuations, and average prices were much the same as in the preceding year. Live stock receipts exceeded those of any previous period; provision trade active; stock of cheese, of which autumn product short, exhausted by foreign demand; hay ruled unusually high; fruit crop abundant, and, though prices consequently low, value of receipts exceeded that of preceding year, when crop was short and prices high.

The wholesale trade of 1891 shows in business done a fair advance over the preceding year, the excellent harvest having enabled increased purchases to be made. In many articles the value has not been greater, though a greater volume has been handled, especially in the wholesale grocery trade, in some articles of which the prices realised were far lower than in 1890. Prosperity, however, ruled throughout. The great activity in the building trade caused an unusual demand for all material consumed in construction. In structural iron and in brick and tile an advance of 10 per cent. is reported, but a smaller quantity of the finer tiles are imported than formerly. In the dry goods business is noticed a large increase in demand for goods of American production, and a corresponding reduction in the sale of foreign goods of superior quality, resulting from the higher tariff. The larger houses may import as much as before the new tariff, but the smaller retailers are said not to have found it profitable to import as many articles of foreign manufacture, the disposal of such goods at the higher figure which duties necessitate being less easy, and some goods, such as underclothing, carpets, and other articles of home production and inferior make, are supplanting the imported article of finer quality. A very large quantity of goods were, however, imported in anticipation of the tariff, and no positive opinion can yet be formed of the effect of the tariff. In jewellery there has been an estimated increase of 20 per cent. In lumber the demand is greater than the supply.

Manufactures were somewhat depressed at the commencement of the year from overstock and monetary depression. The large increase in production in 1890 of $19\frac{1}{2}$ per cent. over that of 1889, has, however, been maintained, and a further increase of $5\frac{1}{2}$ per cent. is estimated. Chicago is yearly becoming more independent of foreign imports, and extending the market for its manufactur[illegible]e wages paid increased from £19,837,000 to £21,588,000, the estimated value of product from £110,928,000 to £116,910,000, the capital employed from £39,175,000 to £43,361,000, and the number of workmen from 177,000 to 180,870. The packing business, the most important industry, including the manufacture of butterine (in which a considerable increase took place), and other products shows a slight falling off. In the iron and steel industry the capital employed and total output increased, though fewer men employed. The metal industries turned out less with increased capital. The McKinley Act has raised the cost of cans, but a large surplus stock was imported in anticipation and no rise has yet taken place in packed goods. In the iron and wood industries there was a falling off in value of product, though capital employed increased. In manufactures of wood value of product slightly increased. Of late the number of musical instruments made has greatly increased. For bricks the price averaged low with a good demand. Scarcely any tile, or terra-cotta, or stained glass is now imported, the domestic product of somewhat inferior quality

being preferred, as the cost is less. In all the above industries, though much more capital is invested, the returns have been generally less, prices having been depressed greatly owing to more competition. Fourteen new breweries were started last year, and there are 814 distillers and rectifiers. In chemicals there is an increase of 20 per cent. in production, and 30 per cent. in cost of labour.

The imports in 1891, though £57,964 less than in 1890, exceeded in value those of 1889 by £331,635. The increase in value of free goods, however, compared with 1889, amounted to £176,225, so that the value of dutiable goods imported in 1891 increased only by £165,410 in the two years; and, not counting free goods, the imports on dutiable goods in 1891 were only £38,325 less in value than those of 1890, and amounted to £2,434,171. The amount of duties levied increased by £169,652 from 1889 to 1891, so that the result of this comparison would be that, since 1889, free goods, dutiable goods, and customs' duties have each increased by £170,000. The condition in 1890 was abnormal, on account of the quantity of goods imported, in anticipation of the McKinley tariff, and probably some of this extra stock was not worked off till the early months of 1891. And again, comparing the imports of 1891 with 1889, and not forgetting the greatly increased trade of the city, the commodities which appear to be most affected by the tariff, and of which the import has decreased, are art materials, cigars, cutlery, diamonds, and precious stones, drug sundries, dry goods, guns, leather goods, needles, plate window glass, and toys and fancy articles. Caustic soda, dried fruits, paintings and statuary, have also been imported in smaller quantities. The cigar and tobacco trade has been revolutionised, and a great impetus given to home manufacture. In dry goods, on account of diminution in the imports, and the greater cost of the foreign product, articles of domestic manufacture have been in much demand. Diamonds and precious stones have decreased almost two-thirds in value. Guns have been greatly affected, and needles have almost disappeared as an import. But china and glassware, dressed furs, iron manufactures, jewellery, looking-glass plates, metal manufacture, paper, smokers' articles, wines, and wood manufactures have largely increased in import, while the value of some other articles imported has increased, and amongst them that of tin-plate. As yet the output of the tin-plate manufactories which have started here scarcely supplies 1 per cent. of the ever-increasing consumption. The exports by lake to Canada, consisting almost entirely of flour, wheat, corn, rye, were more than double. Those of domestic produce to Europe on through bills of lading, consisting chiefly of flour, wheat, corn, clover, and other seeds, fresh beef, lard, cheese, and oil-cake were also large. Competition reduced the value of oil mill products by nearly 50 per cent. The 87 leather businesses increased their capital, but the product was about the same.

Textile industries, including clothing of all sorts, show an enormous increase in the value of production, being stated to have turned out to the amount of £10,825,000, against £7,902,000 in 1890. This is partly the result of larger purchases owing to the bountiful harvest, and partly to the higher duties on foreign goods. The McKinley tariff has raised prices all round. Fewer articles of foreign manufacture were imported, and the cost of such goods is greatly higher. Some of the large houses import as much, or nearly so, as before the tariff came in force; but some of the smaller retailers are said to have given up importing any foreign goods, the cost being such as to make them unmarketable or not easily disposed of, and find the inferior article of domestic manufacture has a readier sale. The consequence has been an increased demand for goods of home manufacture, and a consequent rise in prices, the consumer being now forced to give more for an inferior article. The printing, publishing, and newspaper industries show an increased total output. The demand for bicycles is being almost wholly confined to local manufacture, which is considered quite equal in every way. The return at the Port of Chicago for 1891 gives a total of 20,618 vessels entered and cleared.

MANUFACTURE OF FLOOR MATTING IN JAPAN.

Her Majesty's Consul at Hiogo, in his last report, says it is satisfactory to find that the importance of the floor matting industry has nearly doubled during the past year, and there is every reason to believe that the demand from foreign countries is largely in excess of the present production. The plant from which the matting for export is made also supplies the mats universally used for the same purpose by the Japanese, and the chief producing districts are situated in the provinces of Bizen, Bitchin, and Bingo, on the borders of the inland sea, and Bungo and Chikugo in Kinshin. The seed is planted in December, and the crop is gathered in June and July; the manufacture from the new grass, commencing in August, continues actively until early in the following year, during which interval the chief shipments are made. An interesting feature in the making of this matting is the introduction of a warp of cotton threads, numbering, in the finest qualities, some 360 to the yard, thus producing a fabric which is almost as soft and pliable as cloth; in the cheaper kinds, however, native-grown hemp is used for this purpose, and the difference in the finish is at once apparent. The machines on which the matting is made are all of home manufacture, and of rather complicated and ingenious construction; they are worked by the foot of the operator, two or three persons being required for each machine. Aniline dyes are used in colouring, and such is the skill with which this work is done, that there is seldom the slightest variation in shade in any number of rolls in

the same order. The beauty and variety of the designs offered to the foreign purchaser is somewhat surprising, considering that the trade may still be considered to be in its infancy, one foreign firm having stated that they sent away over four thousand different patterns. The Japanese are so clever and industrious in work of this description that they have, it is said, before them the prospect of a very large and profitable trade, with little fear of injurious competition from Canton matting, which is altogether a different article. Prices for a roll of forty yards in length by one yard wide vary, according to quality and workmanship, from 3 dols. to 15 dols., the principal demand being for qualities costing from 6 to 10 dols. The rolls vary in weight from 35 to 100 lbs. each. The United States are by far the best customers at present, but shipments to the Australian market are becoming more and more important, and Consul Enslie says that before long Japanese matting will probably be in demand all over the world. The value of the export of this article, which was only £86 in 1886, rose, in 1889, to £25,389, and amounted to £104,369 in 1891.

Notes on Books.

YEAR-BOOK OF THE IMPERIAL INSTITUTE. First Issue. 1892.

This first issue of what will doubtless be an annual publication is intended as one step towards the "collection and diffusion of the fullest information in regard to the industrial and material condition of the colonies," which is stated to be one of the principal objects of the Institute.

The conception of the book is accredited to Sir Somers Vine, the assistant-secretary of the Institute, the completion of its scheme to Sir Frederick Abel, the secretary, and its execution to Mr. Fitzgerald, the librarian. The book is intended to deal with the physical geography, the natural resources, and the industries and commerce of the colonies and India. It commences with a brief sketch of the trade of the United Kingdom, showing in tabular form the variations in the imports and exports of each main article of commerce during the past five years, and the countries which export and import them.

The pages devoted to each colony contains a brief historical sketch, an account of its physical features, and details of its trade, population, &c. There are no maps, but in many cases full-page diagrams are given, showing the course of trade during a period of years.

General Notes.

ELECTRICAL STANDARDS.—At the recent meeting of the British Association, Mr. R. T. Glazebrook, F.R.S., presented the report of the Committee on Electrical Standards. The earlier part of the report dealt with the testing of resistance coils, and also of Clark cells. The cells set up by different persons at different places and times gave almost identical values for their electromotive force, thus proving the adaptability of this cell as a standard one. During the year the committee had passed the following resolutions, with a view to their adoption internationally:—"(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance; (2) that 14·4521 grammes of mercury, in the form of a column of mercury 106·3 c.m. long. at 0 deg. C., be the specified column; (3) that standards in mercury or solid metal, having the same resistance as this column, be made, and deposited as standards of resistance for industrial purposes; (4) that such standards be periodically compared with each other, and also that their values be re-determined at intervals, in terms of a freshly set up column of mercury." With regard to the units of current and electromotive force, it was agreed that the number ·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampère, and the value 1·434 as the electromotive force in volts of a Clark cell.

ELECTRICITY IN SWEDEN.—The number of electric installations in Sweden of one kind and another is constantly increasing, and a good many firms have made this branch a specialty. Of quite recent and interesting installations may be mentioned one at Östrand sawmills, where two of Laval's new steam turbine duplex dynamos, of respectively 100 and 50 horse-power, have been fixed, and where they work various machines. They are the first of this type which have been delivered, and they appear to answer very well. The dynamos are directly coupled with the turbines, and owing to the efficiency of the regulator the current is absolutely constant. The larger turbine is fitted with condensing appliances, and the smaller can be used both with and without condensing. Both turbines have governors. The current emanating from these generators is divided amongst thirty electric motors, each of 4 horse-power. At the Önan's Company at the Trallhätta Canal an electric crane has just been installed. The crane in question had previously been worked by hand power, four strong men being required. An electric motor has been placed at the crane, and the electric current is supplied by the lighting machine already at hand; the motor is easily tended by one man, so three men's wages are saved. The electric motor has been fitted with a special appliance, whereby one single handle is enough for completely working the motor.—*Engineering.*

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, SEPTEMBER 23, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, 20th inst. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G, C.I.E., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Alfred Carpmael, R. Brudenell Carter, F.R.C.S , Sir Henry Doulton, Francis Elgar, LL.D., Walter H. Harris, John Biddulph Martin, John O'Connor, William Henry Preece, F.R.S., with Sir Henry Trueman Wood, M.A., Secretary.

TRANSPORTATION COMMITTEE.

A meeting of the Committee was held on Thursday, 15th inst. Present: Sir Douglas Galton, K.C.B , F.R.S., in the chair; Walter H. Harris, Charles Holmes, with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

CANTOR LECTURES.

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By Percy F. Frankland,

Ph.D., B.Sc.(Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

Lecture II.—Delivered May 9th, 1892.

Culture-media.

As already pointed out, the most varied materials have been employed for the cultivation of micro-organisms, but whilst the earlier investigators made exclusive use of liquid media, within recent years solid media have come more and more into vogue. In fact it may be said, without exaggeration, that the great advances which have been made in our knowledge of micro-organisms, during the past ten years, have been mainly due to the introduction of such solid culture-media.

It is not that the micro-organisms prefer the solid media to grow in, for as a general rule, on the contrary, they show a preference for the liquid ones. The advantage of the solid media, however, lies in the greater facilities which they afford for obtaining pure cultivations of micro-organisms, and pure cultivations are the key to bacteriological progress, just like pure reagents are indispensable to progress in chemical science.

We will turn our attention for a few minutes to this important question of preparing pure cultivations, which confronts us in every investigation connected with micro-organisms.

Pure Cultures with Liquid Media.—(1.) The simplest although but rarely available method consists in starting a growth of organisms in a liquid medium, which experience has shown is specially suitable for the particular organism which we desire to obtain in pure culture. When microscopic examination shows that this organism has abundantly multiplied in the medium, we transfer a minute quantity to a fresh portion of the same medium, allow the multiplication to take place there, and then again transfer to a fresh portion of the medium. By repeating this transference a number of times, it is sometimes possible to so purify the growth that finally only one kind of micro-organism is present.

This principle is really abundantly taken advantage of in a modified form in the fermentation industries.

Thus, in the alcoholic fermentation, the wort is artificially maintained at those temperatures at which it is a good culture medium for yeast, but a bad or indifferent medium for such organisms as those of the lactic and acetic fermentations; whilst sometimes additions are made to the wort which are inimical to these objectionable ferments, but affect the growth of the yeast only slightly or not at all. This is notably the case with sulphurous acid, which has long been used in many breweries for the purpose of excluding foreign fermentations. Again, the practice of keeping alcoholic liquids of low strength, such as beer and light

wines, fully charged with carbonic acid gas, is another case in point, as in this way the acetic organism is kept in check, and a free field maintained for the yeast. On the other hand, in the vinegar or acetic fermentation, by maintaining a strongly acid reaction, with abundant aëration, the medium is practically preserved for the undisputed development of the acetic organism.

In this way, however, absolutely pure cultures are but rarely obtained, and, in scientific investigations, the method generally only serves as a convenient means of preliminary purification, before employing some of the more exact processes to which I shall presently refer.

In connection with the use of sulphurous acid as a preservative, we may take notice of some recent experiments which have been made by Linossier, with a view to rendering our knowledge of its antiseptic action more precise.

SULPHUROUS ACID.—TOXIC DOSES PER 1,000 C.C.

	¼ hour. c.c.	6 hrs. c.c.	24 hrs. c.c.	5 days. c.c.
Brewers' yeast	200	100	20	—
Yeast (from raisins)	100	20	20	10
„ (with 0·25 grm. sulphuric acid)	(40)	(4)	(4)	—
Mycoderma vini	200	100	100	40
Aspergillus niger	50	20	10	—

The greatly increased activity of the sulphurous acid, in the presence of the merest traces of free mineral acid, is not only interesting, but might very possibly be of technical value in some cases.

In this connection I may refer to some very interesting results which have recently been obtained by Effront, in the use of mineral acids for the suppression of undesirable fermentations in breweries and distilleries.

Effront found that 100 c.c. of wort were protected from the lactic and butyric fermentations absolutely by ·025 grm. hydrofluoric acid, ·200 grm. hydrochloric acid, ·300 grm. sulphuric acid. And these fermentations were very materially retarded by hydrofluoric acid, 0·002 grm.; hydrochloric acid and sulphuric acid 0·020 grm.

If both ferments are simultaneously present, very much smaller doses of hydrofluoric acid are efficient in suppressing them : thus, 0·0008 grm. hydrofluoric acid greatly retards, and almost entirely suppresses, the more dangerous butyric ferments.

Effront further found that such additions of hydrofluoric acid, instead of injuring the diastatic power of malt, were favourable to it. In some cases the use of ammonium and potassium fluorides was preferable to that of the free acid. The pretensions of the method may be gathered from the following experiment:—

Three kilos. maize were made to yield 10 litres of mash. Using 14 per cent. of malt, there were obtained, without ammonium fluoriode, 57·02 alcohol to 100 parts starch; using 7·5 per cent. of malt, there were obtained, without ammonium fluoride, 54·30 alcohol to 100 parts starch; using 14 per cent. of malt, there were obtained, with 0·02 grm. ammonium fluoride,* 66·98 alcohol to 100 parts starch; using 7·5 per cent. of malt, there were obtained, with 0·02 grm. ammonium fluoride, 66·07 alcohol to 100 parts starch. The method has been tested on a practical scale in several German distilleries—in some cases apparently with much success—and it would undoubtedly appear to deserve trial.

2. The only reliable method of obtaining pure cultures by means of liquid media is far more complex and troublesome than that which I have described. It is known as the "dilution method," and consists in largely diluting the liquid containing the micro-organisms, and then dividing this diluted material into such a number of small fractions that each of these fractions contains not more than one micro-organism. Such a fraction then forms the starting-point for a pure culture of the particular organism.

Although the principle of this second method is obvious enough, and is comprised in these few words, yet its actual execution is in the highest degree laborious and wearisome, success often only being achieved after many abortive attempts.

An idea of the manner in which this method is carried out may be gathered from the following hypothetical case:—Suppose that it has been estimated, by microscopic examination, that about 10,000 microbes are present in one cubic centimetre: then dilute 1 to 100 c.c. with sterile liquid, and inoculate 10 tubes each with 1 c.c., each tube will contain about 100 microbes; inoculate 10 tubes each with ·5 c.c., each tube will contain about 50 microbes; inoculate 10 tubes each with ·1 c.c., each tube will contain about 10 microbes. Then dilute 1 c.c. to 1,000 c.c. with sterile liquid, and inoculate 10 tubes each with 1 c.c., each tube will

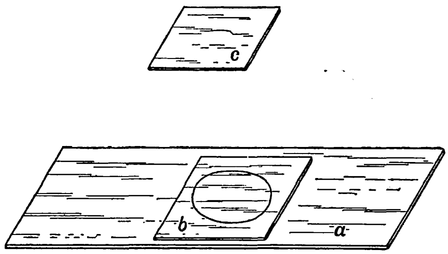
* This was added to half of the 10 litres of the mash obtained.

contain about 10 microbes; inoculate 10 tubes each with ·5 c.c., each tube will contain about 5 microbes; inoculate 10 tubes each with ·1 c.c., each tube will contain about 1 microbe; inoculate 10 tubes each with ·05 c.c., each tube will contain about ·5 microbes.

Of the last ten tubes, then, about five only would develop growths, and these would, in all probability, be derived from a single microbe each, and thus be pure cultures.

In the case of large micro-organisms, like yeast, the method is not nearly so troublesome as in the case of bacteria, for it is comparatively easy to estimate with a fair degree of accuracy how many yeast-cells are present in a given volume of liquid with the aid of the hæmatimeter.

FIG. 7.



HÆMATIMETER. (After Jörgensen.)

(*a*) Glass slide on which the perforated glass square (*b*) is cemented so as to form an extremely shallow circular cell, the depth of which is accurately determined. On the glass bottom of this cell some very small squares of known dimensions are etched. A small drop of the liquid in which the number of yeast cells is to be determined is placed in the cell, and the cover glass (*c*) placed on the top so as to be in contact with the liquid in the cell. The volume of liquid resting on each of the little squares is thus easily calculated, and by counting the yeast cells visible with the microscope in each square, the number in the particular volume of liquid is determined.

It was in this manner that Hansen, in his classical researches, first obtained cultures of pure yeast (1882). I have more recently employed the method for the isolation of the nitrifying organism, but to this I shall refer again later on.

Solid Culture Media.—Considering, then, what enormous difficulties attach to the preparation of pure cultures by means of liquid media, it may be imagined how welcome was the introduction, by Koch, of the new methods of culture on solid media, which greatly facilitated the process of purification.

The commonest solid media employed are gelatin-peptone, agar-agar, and potatoes.

I may take this opportunity of stating the precise composition of some of the more important of these solid media:—

	Gelatin-Peptone.		Agar-Agar-Peptone.
Lean beef	1 lb.	....	1 lb.
Gelatin (leaf) ..	100 grms.	Agar-agar	15 grms.
Peptone (dry) ..	10 grms.	....	10 grms.
Common salt....	5 grms.	....	5 grms.
	1,000 c.c. water.		1,000 c.c. water.

The gelatin-peptone is suitable for cultures not requiring more than 22° C. for their incubation; when higher temperatures have to be employed, the agar-agar-peptone must be used, or some other medium which will remain solid at the temperature in question, *e.g.*, potatoes, hard boiled white of egg, or coagulated blood serum. The latter was formerly the only medium on which the tubercle bacillus could be cultivated, until it was shown by Nocard and Roux that agar-agar, to which about 5-8 per cent. of glycerin had been added, formed an excellent nutritive material for these bacilli, and in fact now the addition of glycerin is almost invariably made for the agar-agar-peptone medium.

Pure cultures may frequently be obtained by simply streaking with a needle bearing the organisms under investigation over the surface of one or other of these solid materials. In so doing each organism is obviously fixed by the solid at the point where it is deposited, and the progeny to which it gives rise by multiplication grows up around it, and these growths, being more or less isolated, are pure, and further pure growths can be obtained by inoculation from them.

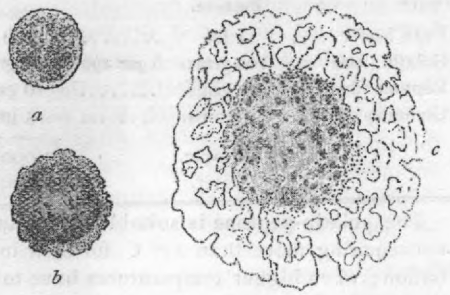
[Demonstration of streak growths of various organisms.]

Such solid surfaces of nutrient materials have also been largely employed by myself and others for investigating the micro-organisms of the air, for if such surfaces are exposed to the air, the micro-organisms present in the latter fall upon them in different places, and thus give rise to isolated growths from which pure cultivations can be propagated.

[Demonstration of gelatin-plates and slices of potato that had been exposed to air, and on which colonies of aërial micro-organisms had appeared.]

Plate-cultures.—A most important modification and advance upon the process I have just described, and which we also owe to Koch, consists in mixing the organisms with a liquefied jelly, thoroughly distributing them in the fluid mass, and then pouring this mixture out on a cold glass plate,

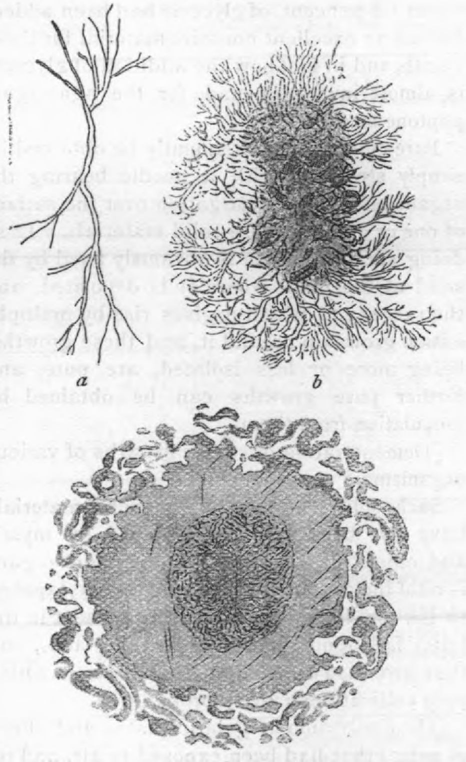
FIG. 8.



COLONIES OF BACILLUS DIFFUSUS* (Percy Frankland) MAGNIFED ABOUT 100.

(*a*), (*b*), and (*c*) represent the successive stages of the colony's growth.

FIG. 9.



COLONIES OF BACILLUS ARBORESCENS† (Percy Frankland), MAGNIFIED ABOUT 100.

(*a*), (*b*), and (*c*) represent the successive stages of the colony's growth.

* Obtained from soil.

† Obtained from water.

on which it rapidly solidifies; on keeping this sheltered from dust in a moist chamber at a suitable temperature, the organisms multiply and give rise to isolated colonies, as they are generally called, each of which is a pure culture.

[Demonstration of a plate-culture with its colonies.]

It is quite impossible to overestimate the benefit which this elegant process has conferred on bacteriological science. Not only does it enable us in many cases to obtain pure cultivations with great facility, but from the appearance of these colonies, when viewed either with the naked eye, or more generally with a low power of the microscope, we are often able to recognise the particular organisms with which we have to deal.

The identification of micro-organisms is often a matter of much difficulty, and entails long practice, but from the foregoing figures you will be able to form an idea of the great assistance which is frequently to be derived from a study of the colonies.

Modifications in Gelatin-plate Process.—Although 10 years have elapsed since Koch first introduced this process of gelatin-plate culture, only trifling modifications—they can hardly be called improvements—have been made in it; indeed, the process is, in many respects, so perfect and simple that it hardly admits of any. The only material modification which occasionally presents special advantages is that introduced by Esmarch, and which consists in producing the gelatin film on the inside of a test-tube instead of on the surface of a plate (Fig. 10, p. 925).

This modification becomes particularly serviceable in the study of the ordinary fermentation organisms, and what are known as anaërobic forms; for the culture can easily be incubated, in the absence of air, or in an atmosphere of any gas that it may be wished to experiment with (Fig. 11, p. 925).

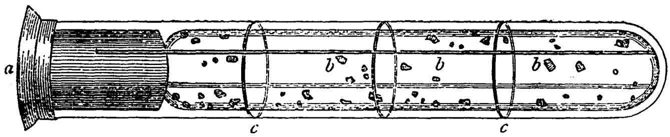
This may often serve as a particularly convenient means of identifying fermenting organisms in the presence of others, as the fermenting organisms are always capable of growing in the absence of air, and they betray their presence in the gelatin film, not only by the formation of a visible colony but by the generation of a bubble of gas, if the gelatin is made with an addition of 1 to 2 per cent. of dextrose.

Instead of using hydrogen to displace air from a culture material, to be used for the

growth of an anaërobic organism, the removal of the oxygen may be effected by means of bacterial life itself, as devised by Roux, Salomonsen, and Buchner. For this purpose a small culture tube is fitted in the ordinary way, sterilised and inoculated with the anaërobic organism under examination; it is then placed in a larger tube containing broth which has been infected with *bacillus subtilis*, or some other organism which rapidly consumes oxygen. This outer tube is then tightly closed with an india-rubber stopper, which may be further coated and sealed with paraffin. The oxygen is rapidly removed from the entire closed space by the vegetation of the *bacillus subtilis* in the outer vessel, thus permitting the growth and development of the anaërobic organism in the inner tube.

Instead of using the culture of *bacillus subtilis* in the outer tube, it is more convenient

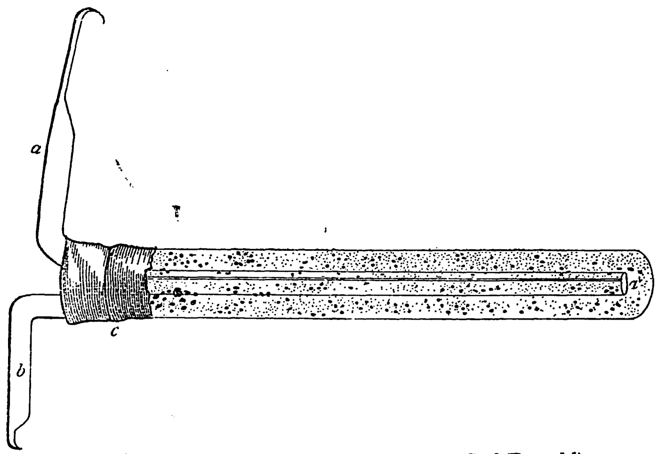
FIG. 10.



ESMARCH TUBE CULTURE WITH COLONIES.

(*a*) India-rubber cap covering cotton-wool stopper; (*b*) numerous colonies in the gelatin-film; (*c*) ink-marks on the outside of the test-tube, to facilitate the counting of the colonies.

FIG. 11.



ANAËROBIC ESMARCH TUBE-CULTURE (Carl Fraenkl).

(*aa*) Glass tube, through which hydrogen or other gas is passed into melted gelatin. (*b*) Exit tube for stream of gas. Both of these tubes are sealed in the blow-pipe, after the gas has been passing for about 15 minutes; the melted gelatin is then made to congeal on the inner surface of the test-tube, by rotating the latter horizontally in cold water. (*c*) Doubly perforated india-rubber stopper, coated outside with paraffin wax. Numerous colonies have appeared in the gelatin-film.

to employ a mixture of caustic potash and pyrogallic acid, which, as is well known, rapidly absorbs oxygen. The arrangement is shown in Fig. 12, p. 926.

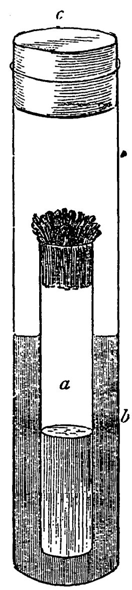
Unfortunately, a number of organisms are known which will not thrive on this gelatin medium; some not at all, and others only at temperatures above that of the melting point of the gelatin.

But, even when organisms will not grow on gelatin, the gelatin plates may sometimes still be successfully used for obtaining pure cultures. Thus, supposing we have an organism which will not grow on gelatin mixed with other organisms which do thrive on this medium, we may make use of the following artifice for securing the organism which does not grow on the gelatin.

Plates are poured off the mixture, and, in due course, the organisms which thrive on

the gelatin give rise to colonies. Now, the organisms which do not grow on the gelatin must obviously lie in the interspaces between these colonies, and, by cutting out some of the interspaces with sterilised instruments, we shall obtain these organisms purified from all those which thrive on the gelatin. This artifice has, indeed, been occasionally most successfully employed. To this we shall have to refer again, in connection with the important organisms which bring about nitrification in the soil.

FIG. 12.



ANAËROBIC CULTURE.

(*a*) Ordinary culture-tube plugged with cotton-wool; (*b*) larger test-tube containing mixture of pyrogalic acid and caustic potash; (*c*) india-rubber stopper coated with paraffin.

A special jelly has recently been devised to meet the requirements of some refractory organisms—like those of nitrification—which refuse to grow on gelatin, and which demand a medium free from organic matter. These may be most successfully cultivated on silica jelly, a preparation which is wholly destitute of organic matter, and in which the gelatinous consistency is secured by means of dialysed silicic acid. To the sterile solution of dialysed silicic acid, placed in a sterile glass dish with flat bottom, a sterile solution of the following composition is added:—

Ammonium sulphate	·4	grm.
Magnesium sulphate	·05	,,
Potassium phosphate	·1	,,
Calcium chloride	trace.	
Distilled water	100	grm.
Sodium carbonate..........	·6—·9	,,

The two are thoroughly mixed, after which gelatinisation takes place in from 5 to 15 minutes. The carbonate of soda may often be advantageously replaced by magnesium carbonate, but the medium is then not transparent.

But even when an organism grows on gelatin it is not always possible to isolate it by the ordinary process of plate-culture, for it may be mixed with other organisms which have the property of peptonising or liquefying the gelatin to such an extent that the organism in question may be crowded out, and the whole plate may have become liquid before it has had time to give rise to a colony of recognisable dimensions. This is a point which must be constantly kept in view by all engaged in isolating particular micro-organisms, and frequently necessitates the use of special methods adapted to the special habits and characters of the organisms under investigation. I may take two examples to illustrate how such difficulties have been overcome in specific cases.

The first case is that of the method which has been devised for identifying the presence of the typhoid bacilli in potable water. These bacilli in such waters are invariably associated with a large number of other forms which grow freely on gelatin and often cause its liquefaction, and as the colonies of the typhoid bacillus grow comparatively slowly, and are but little characteristic, it is quite hopeless to endeavour to detect them in an ordinary plate-cultivation of a sample of water. Under these circumstances, advantage has been taken of the ascertained fact that this typhoid bacillus is particularly insusceptible to doses of carbolic acid.

In order to apply this peculiarity to the detection of the typhoid bacilli, a number of tubes, each containing 10 c.c. of neutral bouillon, are prepared, and to these are then added from ·1, ·2, and ·3 c.c. of the following solution:—

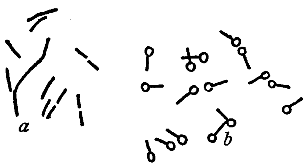
Carbolic acid	5	grms.
Hydrochloric acid	4	,,
Distilled water............	100	,,

These tubes are then inoculated with 1 to 10 drops of the water under examination, after which they are placed for twenty-four hours in the incubator at 37° C. Under these circumstances most of the microbes present in natural

waters are destroyed, whilst the typhoid bacilli multiply abundantly. From these broth-tubes, after incubation, gelatin plates are now poured in the ordinary way, the colonies of the typhoid bacilli, should they be present, can easily be discovered, and their identity proved by confirmatory tests, such as their characteristic growth on potatoes, presence of flagella, &c.

The second case, which illustrates in the most instructive manner how the special properties of a microbe may be taken advantage of for its isolation, is that which was resorted to with such signal success by Kitasato for the bacillus of tetanus. This organism, as present in the pus of a wound which has caused tetanus, is always surrounded by a number of other forms. The first step in the purification of the bacillus consists in taking advantage of the fact that it is anaërobic, *i.e.*, that it grows in the absence of oxygen, to this end the pus is cultivated in an atmosphere of hydrogen; under these circumstances it grows freely, but so do also some of the other organisms with which it is mixed. Kitasato, however, observed that there was an important difference between the tetanus bacillus and these other organisms, for he found that the tetanus bacillus developed spores at a much earlier period than any of the microbes with which it was associated. Now the possibility of arriving at a successful issue was at once apparent. Taking advantage of the well-known fact that spores are capable of resisting for some time high temperatures which are rapidly fatal to the vegetative or fully developed microbes, he proceeded to heat the cultures as soon as these tetanus spores had made their appearance, and by maintaining the temperature at 80° C. for some time, all the organisms, excepting the spores alone, were destroyed, and inasmuch as only the tetanus bacilli had formed spores, a pure culture was thus obtained.

FIG. 13.



TETANUS BACILLI. (Kitasato.)

(*a*) Sporeless bacilli; (*b*) bacilli, each bearing a spore at its extremity, giving rise to club-shaped forms.

I have not hesitated to bring before you these illustrations, although at first sight they may appear foreign to the subject of my lectures, because I am convinced that it is of the utmost importance that those who are engaged in one department of bacteriology, *e.g.*, in that which deals with fermentation phenomena, should constantly bear in mind the methods which have been found useful, and the discoveries which have been made in other departments of the same science.

FIG. 14.

STREPTOCOCCUS OF ERYSIPELAS.

FIG. 15.

SPIRILLA OF ASIATIC CHOLERA, COMMONLY KNOWN AS "COMMA BACILLUS" OF KOCH.

FIG. 16.

TYPHOID BACILLI. (After Migula.)

In conclusion, I would draw your attention to Figs. 14, 15, and 16, representing some of the best known pathogenic forms of micro-organisms.

Miscellaneous.

IRRIGATION IN INDIA.

According to any official summary, issued from Simla, of the review of the Government of India of the revenue and expenditure connected with irrigation, the record of the past year shows how very remunerative such works are. On productive works, to the end of 1890-91, the direct outlay has amonnted to Rx. 25,465,000, upon which a net return of 4·81 per cent. is derived, without taking into account the old irrigation system in Madras. If this were included, the average return from all productive works would amount to 5·8 per cent. These aggregate results include figures relating to projects such as the Chenab Canal, in the Punjab, and the Sangham and the Periyar projects in Madras, which were still in various stages of construction during the year

under review. The capital outlay on these is unproductive until complete, and the general average return is reduced in a corresponding ratio. The same remark applies to the large addition made to the capital outlay of the Lower Ganges Canal, on account of the new aqueduct over Kalinadi, at Nadrai, as it will take time before irrigation can recover from the check caused by the failure of the original aqueduct. The figures also include those relating to the Orissa project, in Bengal, and the Karnul Canal, in Madras. These two works were first undertaken by companies under a 5 per cent. guarantee from Government, but being entirely unproductive the companies were bought out. The capital outlay on these two projects has amounted to Rx. 4,585,919, on which large outlay there is less than no return, the working expenses during the year having exceeded the receipts by Rx. 12,707. On the other hand, the returns from some of the works are extraordinarily good. Out of 35 irrigation works classed as productive, 15 yielded over 4 per cent. on their capital outlay, ranging from 40·2 per cent. in the case of the Cauvery system in Madras to 4·5 per cent. in the case of the Agra Canal in the North-West Provinces. On the whole, returns from the systems which really fulfil the condition of being productive are more than sufficient to cover the deficits on the systems which, though classed as productive, do not attain to the necessary standard. The aggregate profit to the State to the end of 1890-91 on account of the former, after paying 4 per cent. interest on capital outlay, amounts to Rx. 10,735,022, whereas the deficit on account of the latter, including accumulated arrears at simple interest, amounts to Rx. 6,620,520. The net profit, therefore, amounts to Rx. 4,114,502. In 1886 the area irrigated is shown as 5,292,733 acres, bringing in a gross revenue of Rx. 1,813,185. In 1890-91 the area was 7,172,468, and the return Rx. 2,312,787. The estimated value of crops grown under major and minor works in 1890-91, excluding those in Sind, for which figures are not available, was Rx. 24,544,110 from an area of 7,984,275 acres, giving a value of about Rx. 3 per acre. The estimated value of the produce of one year is thus nearly equal to the whole of the direct capital outlay incurred on works sanctioned. The projects are Jhelum, Kalingaroyen, Chenab Extensions, and the Lower Ganges Canal, which it is reckoned will irrigate 1,291,260 acres, and return a net revenue of 13·30 per cent. The Chenab Canal Extension project has just been sanctioned, and will take precedence of the Jhelum Canal, sanctioned in 1888, funds for both being available. The Kalingaroyen Canal in Madras has also been sanctioned, but the commencement of work has been deferred for the same reason. The Lower Ganges Canal Extension project has been submitted to the Government of India by the North-West Provinces Government, but has been returned for revision. In addition to the above, a large and profitable outlay is contemplated on works in Upper Burmah, where scientific irrigation is still in its infancy. The Government of India is also awaiting the receipt of proposals from the Bombay Government for the improvement and extension of irrigation in Sind, upon which a committee assembled in the early part of the current year.—*The Times.*

HORSE BREEDING IN BELGIUM.

According to a recent report by the United States Consul at Brussels, Belgium possesses two pure equine races, the Ardennes horse, native of the valley of the Meuse, and the Frisian, a species of which inhabited the sea-coast. From the union of these two breeds issued the Brabançon horse. The draught horse in Belgium is generally divided into three grand divisions—(1) the race of the littoral, (2) the Ardennes, and (3) the Brabançon. Great care has been taken in the breeding of horses in Belgium, and the animals bred there are, with the exception of the shire horses of England, the largest draught horses in the world, and finely proportioned. The Ardennes horse, which is perfectly adapted to mountainous regions, is an excellent type of the light draught horse. This animal is, however, rapidly disappearing, owing to the fact that the Luxemburg farmers prefer the heavy draught horse, and the introduction of large heavy stallions into the province from Brabant and Hainault has almost completely transformed the breed. The export to Germany and Austria of the best stallions has also contributed greatly to the disappearance of the stock. Ardennaise colts readily sell before they are a year old, the price varying according to their condition. For several years much attention has been devoted to the improvement of the Brabançon horse. The line of the back is now much straighter, the neck and shoulders more proportionate, and the legs large and clean. This animal harnessed to one of the heavy carts of the country, weighing about 3,000 pounds, pulls on the level a load weighing from 6,000 to 10,000 pounds, and works from eight to ten hours daily. The results of the exhibition of Paris in 1878, Brussels in 1880, and Antwerp in 1885, prove that there are now no distinctly pure breeds in Belgium, although such have existed. At the present time there remain but two varieties, the heavy and light draught horse. The special characteristics of the Belgian draught horse are stature, form, strength, and breed. He has less bulk and strength than the Clydesdale or shire horse, but is better bred and has more energy. He has more bulk and strength than either the Percheron or Boulonnais horse, and possesses as much energy. About the year 1850, the Belgian Government established, at Tervueren, a depôt for stallions. This was not a stud, but simply an establishment where stallions were admitted, the number being limited to sixty-five. Thoroughbreds, half-breds, and a few Percherons were admitted, but no

native stallions were accepted. When the Government stud existed, it bought annually a certain number of stallions, which were collected in a central depôt until the end of February, when they were distributed, for gratuitous covering, throughout the provinces until July. The cost per stallion per annum to the Government was about 2,000 francs. The number of coverings averaged about 36 per stallion, which resulted in from 900 to 1,000 colts. After the Government stud was suppressed, horse breeding was abandoned to private enterprise, encouraged by subsidies. Since 1841, there have existed in the Belgian provinces regulations, approved by the Government, for the improvement of the equine race. These regulations were framed, in the first place, to prevent breeding from stallions judged unfit to improve the race, as far as being destined to cover mares other than those of the owner; and, secondly, to institute a system of prizes and competition and of registration, to the profit o owners of stallions and mares. Obligatory examination is in force in all the provinces. Only stallions approved by a Commission may be publicly employed. The encouragements offered are as follows: —Local competition prizes for colts and stallions three years old, and from four to nine years; provincial prizes for the best, or the two best, stallions, irrespective of locality, and a registration prize accorded to stallions, which at five years of age have obtained a first prize in the category of stallions from four to nine years. In the provinces of Antwerp and Liège, the examining commission is limited to the examination of the value of the stallions submitted to their examination, and declarations as to fitness for breeding purposes. In the province of Antwerp, there are two prizes for each of the three meetings, the first 500 francs, and the second 340 francs. In the province of Liège there are four prizes, divided between four meetings of heavy draught stallions from three to seven years of age. According to the last agricultural census, the number of horses in Belgium amounted to 271,975; about 50 horses to every 1,000 inhabitants. The average selling prices during the years 1890 and 1891 were—stallions, 3,000 to 4,500 francs; mares, 1,800 to 2,400 francs; and colts, 2,000 to 2,500 francs.

AGRICULTURE IN BERMUDA.

The principal productions of Bermuda are onions and potatoes, which are chiefly exported to New York and Boston during the months of March, April, and May, commonly called the "crop season." The United States Consul at Bermuda says that potatoes are usually planted in December and January, except in exposed places, where they are not planted until February, so that they may escape the high winds of winter. The seed potatoes are imported from New York, Nova Scotia, and Prince Edward Island in the winter. These potatoes are cut in sections, one or two eyes in each section. The ground being well manured, the potatoes are planted in drills about 20 inches apart. When half-grown, artificial manure and castor pumice are thrown around the plants. In about 90 to a 100 days after planting, the potatoes are fit to dig. They are sorted in first or second sizes, in accordance with the Colonial Inspection Act, and packed in barrels. About eight barrels of first size potatoes from one barrel planted is considered a fair yield, although twelve and even fifteen barrels is not uncommon. Onions are grown from the red and white onion seed imported from the Western Islands and the Azores, by way of London and New York. This seed is packed in hermetically sealed tin cases, and is transferred by the importer to common black pint and quart bottles, which are sold at 75 cents a pint. The seed is planted in beds from 50 to 100 feet long and about 4 feet wide, with walks between the beds for convenience in cleaning and weeding the young plants, which, when sufficiently grown, are set out in permanent beds, where they increase in growth and the bulbs begin to fill. Onion seed is sown in September and October, and the plants are set out in December and January. The harvesting of the onions begins in the latter part of March and ends the latter part of May. Onions are put up in boxes holding about fifty pounds. Farmers bring their potatoes and onions to the town of Hamilton for sale or shipment. Many other vegetables are grown in Bermuda, but with the exception of beets, not in sufficient quantities for exportation. Very little fruit is grown. There being no frost, flowers bloom all the year round, and lily buds and bulbs are largely exported to the United States. An attempt at silk culture is, says Consul Sullivan, being made by an enterprising Bermudian, who has strong hopes for the success of his experiment. In many cases the farms are owned by the farmers—none are owned by companies. Merchants and others who own land rent it out at so much a year, or on shares. Bermuda was originally laid out in parishes, of which there are nine. These were subdivided into shares of land, in 1690, each share containing 25 acres. This still remains so, and some tenants rent several tracts of land in different localities. Not more than 50 acres are usually held by one person. Portuguese from the Western Islands are large growers of produce. They are generally industrious and thrifty. Under what is known as the Alien Act, no person who was not born on British soil and is not a British subject can purchase and hold land in Bermuda. Permanent investment in land by a foreigner is not allowed.

THE FISHERIES OF CANADA.

The sea fisheries of Canada, which are situated off the coasts of Nova Scotia, New Brunswick, Prince Edward Island, Quebec, and British Columbia, are among the richest and most important in the world,

while according to a report recently issued by the Canadian Government, the fresh-water fisheries of the great lakes and rivers of the country are nowhere to be surpassed. During the last few years there has been a steady increase in the value of the product of fisheries, the increase in 1891 over 1890 amounting to 1,263,176 dollars and over 1888 to 1,559,568 dollars. There was an increase in the value of the yield in each province except British Columbia and Ontario, the largest increase having been in New Brunswick. The number of boats employed in the fisheries of the several provinces in 1891 was 31,464, and the value amounted to over 3,000,000 dollars. The number of men engaged was 65,575, and the total value of all the fishing material was over 7,000,000 dollars. British Columbia employs about 700 men and 30 vessels in the seal fishery. A Fishery Intelligence Bureau was inaugurated on a small scale in 1889, which appears to be much appreciated by those interested in the fishing industry. In 1890, there were eleven Government fish hatcheries in operation, and the number of eggs collected in the autumn of that year for subsequent hatching was nearly 145,000,000. Another fish hatehery has recently been established at Ottawa. The great benefit of these hatcheries to the fisheries generally is nniversally acknowledged, and it is said that the heavy runs of salmon in recent years on the Fraser River are largely due to the operations of the hatchery there. The yield of the Canadian fisheries in 1891 was 18,978,078 dollars, or more than four times as much as it was in 1890. In addition to the above, large quantities of fish are annually consumed by the Indians, particularly in the North - West and British Columbia, of which no account can be obtained. For the period comprised between the years 1879-81, the value of fish so consumed has been estimated at about 50,000,000 dollars. As regards the yield by provinces for the period comprised between 1869 and 1891, Nova Scotia has produced during this period 47 per cent., or nearly one-half of the total yield, New Brunswick, 19 per cent., and Quebec 14 per cent., the three provinces having yielded 80 per cent. of the total. The fishing industry in British Columbia is yet quite in its infancy, but the opportunities for its development are said to be most advantageous, and the deep-sea fisheries are unsurpassed in wealth and variety. The fisheries of the great lakes are the largest and most important fresh-water fisheries in the world; and the great value of the Canadian portion of these fisheries is not generally appreciated. The area of fresh water belonging to Canada in the Lakes Superior, Huron, Erie, and Ontario is about 72,700 square miles; and, in 1890, 1,203 vessels and boats, manned by 2,920 men, using 1,441,695 fathoms of nets, were employed in fishing therein. Whitefish, salmon, and lake trout, sturgeon, herring, bass, and pickerel are the principal fish. According to the census returns of 1890, the fish caught on the United States sides of the lakes in that year showed an increase of 58 per cent. in value, as compared with 1880; while the value of the fish caught on the Canadian sides in the same year showed an increase of more than 350 per cent. on the catch of 1880.

SMYRNA SPONGE TRADE.

The following extracts from the reports of Mr. F. Holmwood, Her Majesty's Consul-General at Smyrna, on the sponge trade of Turkey, is quoted from the *Board of Trade Journal*:—

"The value of the sponge trade during the year 1891 is stated to have diminished from 20 per cent. to 25 per cent., as compared with that of the preceding year, and this statement is borne out by the diminution in the amount of the 'charitable dues' levied by the communities of the various islands interested in the trade, viz., Symi, Calymnos, and Halki.

"The 'charitable dues' are a tax levied by the communities of the different islands interested in the sponge-fishing industry, who with the proceeds are enabled to defray the expenses incurred in the maintenance of the doctors, dispensaries, schools, &c., in their respective islands. It is leviable at the time of sale to the amount of 2½ per cent. on the value of the sponges sold, the seller paying 1½ per cent. and the buyer 1 per cent., and is considered obligatory upon all.

"The amount of sponges of the best quality was less than that obtained during the season of 1890, but very high prices were given by merchants for those of the finest quality, especially for those taken at Mandruha and Crete, where the average size of the finest sponges exceeded that of those fished during the previous season.

"Sponges of inferior quality, especially those taken at Zohara, were sold at very low rates.

"While the districts in which the sponge-fishing industry is carried on are showing signs of exhaustion, on the other hand new fields are discovered from time to time; but it is to be feared that the increase in the produce of the season afforded by the discovery of new fields does not altogether compensate for the loss occasioned by the exhaustion of districts which have long been in use.

"With regard, however, to the number of men employed in the industry, a considerable increase is recorded. It appears that, whereas some years ago, to each boat using the diving apparatus, four divers were allotted out of a crew of 15; now six, and even as many as eight, divers are employed, the crew often numbering 20 all told.

"Unfortunately, the evils mentioned in a former report, as tending to reduce, if not to destroy, this industry, still continue, and especially the dishonesty of the men employed, who not infrequently take advantage of the faulty system of prepayment of divers, which obtains in the trade, to rob their employers.

"The evils referred to were as follows:—

"First, the competition of the American sponges, which, though inferior in quality to the finer sorts of sponges obtained here, are able to compete with the coarser kinds in the European market.

"Secondly, the thoroughly faulty system that obtains with regard to the hiring of the divers and crews by the boat owners, who, being compelled to pay large sums in advance to the divers before the boat starts, are generally obliged to have recourse to capitalists, from whom they borrow money at usurious rates of interest (16 per cent., 20 per cent., and even 24 per cent.), and thus encumber themselves with heavy debts amounting to at least £1,000 for each boat before a penny has been earned. Again, when all is ready, the advance money demanded by the sailors and divers paid, and the contract duly signed, it is not an uncommon occurrence for one or more of the men to demand an extra gratuity, and to refuse to work unless their employer complies with the most preposterous demands; the boat owner is then obliged to give way, or else to abandon the enterprise, as, in the present state of the law, the only legal measure he can adopt is to bring an action against his dishonest *employé* for recovery of debt (a measure obviously useless in cases where the *employé* is already indebted to his employer, and unable to pay the debt, except by honest fulfilment of his part of the contract).

"Thirdly, the introduction of the diving apparatus, though it gave at first a great stimulus to the trade by enabling divers to obtain a greater quantity of sponges, has had an unfavourable effect by exhausting the supply of sponges in the shallower waters, and thus necessitating recourse to the deeper waters, where the risks of this dangerous occupation are increased. The divers are now obliged to descend from 25 fathoms to 32 fathoms, whereas the instructions accompanying the diving apparatus give 20 fathoms as the maximum limit of depth for which they can be used with safety.

"Fourthly, the appearance of a submarine plant of rapid growth, which covers the sponges, and causes them to rot, seemed likely to prove the most serious evil with which the trade has to contend, had it not been diminished in extent. Recently, some specimens of this plant have been sent to be examined by scientific authorities in Europe, and it is hoped that a means will be suggested by which the evil may be wholly removed.

"Again, as more divers are employed in each boat, larger sums are now required to fit out the boats; and it must also be added, that the risks of the occupation have increased, as divers descend to greater depths to obtain the sponges. As many as 80 cases of fatal accidents are reported as having occurred among divers using the apparatus during the past season.

"The boats in which the diving apparatus is used number 126, with crews amounting in all to 2,520 men. Boats, in which the naked divers are employed, number 140, with crews amounting to 980; while 720 men were employed in 180 boats in which the trawling apparatus is used.

"The practice of fishing in the winter season is becoming more general, but, as the districts in which the winter fishery is carried on are gulfs or places near the coast, and thus quite distinct from those used during the summer, the results of the summer fishery are not thereby affected.

"Fortunately, the reports of the parasitical weed, whose appearance in the sponge districts some years ago caused so much anxiety, show that the evil continues to decrease.—*Nos.* 764, 894, *and* 1,062, *Foreign Office Annual Series.*

AUSTRIAN CO-OPERATIVE SOCIETIES.

Her Majesty's Secretary of Embassy at Vienna says, that the signal success of the co-operative movement in Germany has led to the establishment in Austria of numerous institutions having for their object the improvement of the economic condition of the working and trading classes by means of combination. As early as 1868 there existed in the great industrial centres of Northern Bohemia, Moravia, and Lower Austria, 330 institutions of this kind, with a capital of 4,500,000 florins (about £375,000); this number in 1889 had increased to 1,916. Of the former total about 25 per cent. were associations for the supply to their members at cost price of food, firing, and other necessaries, while 70 per cent. were devoted to the loan and banking departments; and, as in 1889, the proportion of the latter had amounted to 1,464, they seem destined to hold their own against the productive and distributive sides of co-operative organisation. The Austrian Government, with a view to bringing into play the forces of individual exertion and economical thrift, and in order to counteract socialistic theories and inclinations among the trading and working classes, passed an Act dealing with the *Erwerbs und Wirtschaftsgenossenschaften* (business and industrial co-operative societies). In this Act, the scope of the *Genossenschaft,* as originally concerned, is considerably extended. The object is declared to be "the furtherance of the industrial gain and economy of the associates, by means of carrying on business in common," thus permitting not only production, distribution, and loan associations, but also the conduct of affairs which come under the commercial code and constitute ordinary business operations, such as buying and selling land, agricultural and forest products, with all the varieties of ordinary undertakings within the sphere of industry. Among the societies started according to the enactments of this Act, distributive societies show the greatest amount of variety. These may be divided into four classes. (1) Those established in certain localities, towns, and districts, and which, if working in the general supply business, keep extensive stores and warehouses in public thoroughfares,

They derive their custom from all classes of the population, every purchase being paid in ready money, and the profits divided at the end of the year. Membership in some of these *Consumvereins* reaches the figure of 20,000. They often compete severely with shop-keepers and small traders, and as they frequently extend their dealings beyond their own members, in contravention of the law which secures exemption from certain taxes, they have repeatedly been made the object of fierce antagonism on the part of those who think themselves injured by them. (2) Societies in connection with the great bodies of workmen in industrial undertakings, and in State and private railways. These are worked on the principle of business management and profit sharing, and give facilities to their members by granting them credits within a certain per centage of their wages. (3) Societies for supplying raw material to tailors, shoemakers, basket-workers, &c. These have been established to enable small tradesmen to compete with manufacturers on a large scale, and with a view to resisting the sweating system. In some cases, such as mother-of-pearl workers, and button makers, a special reason for combination lies in the want of adequate capital to buy the high-priced materials at reasonable rates. In the tailoring, bookbinding, and other small trades, combination has proved ineffectual in resisting the combined advantage of machinery and capital. (4) Under this heading come different kinds of stores which mostly, with the assistance of employers who supply both buildings and capital, form part of the benefit institutions of factories. Though not universally favoured by the working-classes, who feel the necessity of purchasing from them as an interference with their freedom of choice, many are in a prosperous condition, and some, such as the co-operative store in connection with the arms factory at Steyr, with a membership of 4,000, are carried on upon a scale of magnificence. The inspectors suggest that it would add considerably to their popularity were the workmen always to have a share in the management. Other forms of distributive co-operation need only passing mention. Among these are the benefit building societies, established for the purpose of buying sites in outlying districts of large towns for lodging houses, &c. These institutions are patronised chiefly by clerks and *employés* drawing monthly or annual pay, and only benefit the working-classes indirectly by relieving the overcrowded condition of more densely populated districts, and thus lowering rents. Passing to productive associations, it may be said that these have, as yet, shown no satisfactory development. Their total number is a little over 200, and of these more than one-half have their business in the metropolis; the trades for which they exist are piano makers, turners, bronze workers, potters, and bakers. The last and most important are the associations of credit—the most highly developed of the class, in possession of great and growing funds, and a highly effectual means of diffusing capital among those who would otherwise fall into the hands of usurers, and of enabling the small tradesmen to compete with the capitalists. One of the principal of these institutions is a general trading bank in Vienna. The objects of this institution are—(1) the provision of machinery and tools, to be paid for by instalments, as agreed between the tradesman and the society; (2) the granting of loans on account of debts due by private persons, this form of loan applying especially to cases when in order to obtain contracts, caution money has to be deposited, or part of the sum contracted for has to be left by way of security for the carrying out of the work; (3) the establishment of warehouses for industrial products, and granting advances for the goods stored in them; (4) effecting sales on commission of the goods stored in these warehouses; (5) the formation of associations where industrial undertakings can be carried on, and motive power used in common.

Notes on Books.

A Handy Book for Brewers. By H. E. Wright, M.A. London: Crosby Lockwood, and Son. 1892.

The object of this book is stated to be "to give the conclusions of modern research, in so far as they bear upon the practice of brewing, in such a form that a novice of fair intelligence may understand them." The author commences with a general introduction in which the whole process of the manufacture of beer is described, from the malting onwards. Technical details are thus taken up in succeeding chapters. The subjects treated include "Barley, malting, and malt," "Water for brewing," "Hops," "Chemistry as applied to brewing," "Ferments," &c. There are also special chapters on the various processes, and a final one on "The brewery and plant."

General Notes.

Chicago Hotels.—A small Committee has lately been appointed by the Executive Committee at Chicago to make special efforts to secure moderate rates for visitors to the Exhibition, on the occasion of the dedicatory ceremonies next month and during the Exhibition. Much work has already been done in this direction by the "Bureau of Public Comfort," and it is intended that the hotels of the city shall be classified, and a uniform scale of charges published. This can be more readily done in America, where it is the practice to make an inclusive charge for board and lodging, than over here.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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Proceedings of the Society.

CANTOR LECTURES.

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By Percy F. Frankland,

Ph.D., B.Sc.(Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

Lecture III.—Delivered May 16, 1892.

Having now made ourselves acquainted with the important methods of handling micro-organisms which have been developed mainly during the past ten years, we must turn to consider some of the principal results which have been achieved by their means.

It must be noticed, in the first instance, that during the greater part of these ten years, the modern methods of bacteriology have been mainly employed to elucidate problems connected with the cause and communication of disease, and in this department truly astonishing strides have been made. It is only within the latter half of the decade that much serious work has been undertaken in connection with the chemical changes brought about by micro-organisms, but there can be no doubt that this side of bacteriology will annually absorb more and more attention, as the problems involved are really of more fundamental importance, although not invested with so much sensational interest.

There can be no doubt that the investigations of a practical character, in which these recent bacteriological methods have been utilised, which have attracted most attention, are those of Christian Hansen, whose name is so familiar throughout the brewing world. I do not propose entering into a description of his researches, which have been very comprehensively dealt with here in a course of Cantor Lectures by Mr. Gordon Salamon, in the year 1888. We may, however, summarise the work of Hansen by saying that whilst Pasteur showed the advantages of brewing with yeast free from other micro-organisms, Hansen has further industrially demonstrated what Pasteur had also indicated, viz., the advantages of brewing with particular species or varieties of yeast. As far as this country is concerned, however, Hansen's researches have hitherto been of little more than theoretical interest; scientific men and brewers have made themselves acquainted with his results, and in some cases have conducted laboratory experiments on the same lines, but in hardly a single instance, as far as I am aware, have his methods been introduced or adopted on a large scale.

But although Hansen's methods have gained no footing in this country, it must not be supposed that they have undergone no further development; on the contrary, we learn that his pure yeasts have been adopted in bottom-fermentation breweries in all parts of the world, and even in top-fermentation breweries they have been used with great success in Denmark, Belgium, France, and Australia. Of great theoretical interest are some recent researches of Hansen's which open out great possibilities in the future. In these investigations he has found that it is possible to produce artificial varieties of yeast, the acquired properties being transmitted from one generation to another, apparently indefinitely; it is obvious that we have here the beginnings, on a microscopic scale, of practices which have long been carried out on the higher plants in floriculture.

The production of more or less permanent varieties of other micro-organisms than yeasts is also attracting much attention at the present time, and is throwing much light on the subject of heredity and evolution.

A striking instance of variation has recently come under my observation in connection with a bacillus which has the property of fermenting calcium citrate; this power it has continued to exercise for years, but if it is plate cultivated, and one of the colonies then introduced into a solution of calcium citrate, I find that the latter is never fermented, the bacillus having lost its fermenting power through cultivation in the gelatin medium. If, however, one of the colonies in question is put into a broth-solution of calcium citrate, the latter is fermented, and on then passing the bacillus from this to the calcium-citrate solution, which it before failed to act upon, it now sets up fermentation in this also.

Perfectly similar phenomena are also fre-

quently observed in the case of pigment-forming bacteria; the power of producing the particular pigment may be permanently lost unless some special treatment is resorted to in order to restore the power. One of the most striking instances of this kind is that of the well-known *bacillus prodigiosus*, which produces a magnificent crimson pigment, the power of producing which becomes, however, gradually lost if it is continuously cultivated on gelatin or agar, and immediately restored if the organism is transplanted to potatoes.

This possibility of producing more or less permanent varieties of micro-organisms has greatly complicated the problems of bacteriology, and shows how very far we still are from having any sound basis on which to establish distinct species. The construction of species was first attempted on a morphological basis, difference of form being made the dominant principle. It is unnecessary for me to remind you how completely this artificial morphological classification has collapsed. The classification has been attempted on physiological lines, but this has proved equally untenable, for a given organism may be made to entirely modify some of its most striking physiological characters. Thus, a fermenting organism, as I have shown, may be made to lose its fermenting power—a pathogenic form may be deprived of its sting, so to speak, and lose its virulence either temporarily or permanently. Again, the construction of species has sometimes been attempted on culture characteristics, such as the liquefaction or non-liquefaction of gelatin, production of pigments, appearance of colonies, &c. All these points, although extremely valuable for purposes of diagnosis, cannot be applied so rigidly as to warrant their being used for the purpose of absolute classification. Perhaps a point which has been more implicitly believed in than almost any other, for the purpose of distinguishing micro-organisms, is their property of producing or not producing spores under prescribed conditions. This test, however, entirely breaks down by the light of the extremely important discovery by Roux and Chamberland of what is called "sporeless anthrax." These investigators have shown that, by suitably cultivating the anthrax bacilli in media to which a small amount of an antiseptic has been added, a race of bacilli is obtained which differ from the ordinary anthrax bacilli in being unable, under any known conditions, to form spores. This asporogenic character is permanent, and is maintained even though they be cultivated on the most diverse media, aye even though they be made to pass through the system of an animal, for they are not in any way attenuated but fully virulent. We must not hesitate to confess, therefore, that although our knowledge of micro-organisms has so enormously increased within recent years, we are still destitute of any foundation on which to establish a differentiation into species. It is, moreover, precisely this instability of properties, and the comparative facility with which they can be moulded at the will of the experimenter, that renders the study of micro-organisms so fascinating and attractive.

FIG. 17.

SPORELESS ANTHRAX BACILLI.

A point of great interest in connection with the introduction of pure yeast fermentations is the influence of the pure yeasts on the formation of the well-known by-products—glycerin, succinic acid, and higher alcohols. There was a very general impression in some quarters that the higher alcohols were due to fermentations induced by extraneous yeasts, and that each particular yeast, if employed in a pure state for fermentation, would give rise to only one alcohol. This matter has as yet been but very imperfectly investigated, but, from some recent experiments of Perdrix, it appears very probable that the amyl alcohol, which is such a constant product of the fermentation of potato-mashes, may be the result of a subsidiary fermentation set up by anaërobic bacteria, which are specially favoured by the presence of starch.

There is also some evidence that the formation of higher alcohols is, to a certain extent, dependent on the temperature of fermentation. Thus, Lindet has found that there is a somewhat larger proportion of higher alcohols produced in fermentations carried on at a high than at a low temperature, thus using the same mixture of top and bottom yeasts; in each case the following results were obtained:—

Temperature of Fermentation.	Crude Alcohol.	Higher Alcohols.	
Deg. C.	c. c.	c. c.	Per cent.
32–35	675	3·9	·58
25–27	1607	9·6	·59
19–21	1834	9·9	·54
8–10	1877	9·7	·52

It is much to be regretted that these experiments were not made with pure yeasts, as the interest attaching to them would have been very much greater.

In the matter of glycerin production, it also appears, from Borgmann's experiments, that less of this material in proportion to the alcohol is formed when pure yeasts than when the ordinary mixed yeasts are used. Thus :—

	Ordinary Lager beers.		Beers produced with Carlsberg.	
	Max.	Min.	No. 1 yeast.	No. 2 yeast.
Alcohol : Glycerin...	100 : 5·497	100 : 4·140	100 : 2·63	100 : 3·24

As regards the theory of the alcoholic fermentation, it must be admitted that we are still very much in the dark, especially as Pasteur's original explanation of the fermentation phenomena being due to yeast life, in the absence of oxygen, is not borne out by recent experiments. For, not only has it been shown that the same changes take place when the yeast is grown with abundant access of oxygen, but the quantity of the fermentation products is actually greater than when oxygen is excluded. In defence of Pasteur's theory, this has generally been accounted for by assuming that the presence of oxygen increases the proliferation of the yeast, and that the larger number of yeast cells then give rise to a larger quantity of fermentation products than do the smaller number of yeast cells which are present when oxygen is excluded. Some very interesting experiments have recently been instituted by Mr. Adrian Brown, which go very far towards undermining this ingenious explanation.

In these experiments Mr. Brown has estimated the quantity of yeast, both by counting the number of cells with the haematimeter, and also by actually weighing its amount. He conducted his experiments in such a manner that the number of yeast cells could not multiply during the fermentation, thus avoiding this complicating factor; and, in all cases, he found that there was more alcohol produced, when oxygen was abundantly supplied, than when it was excluded from the yeast. Thus—

No Multiplication of Yeast Cells.

(*a.*) Air excluded....	3·35 grms. alcohol in 120 c. c.	
(*b.*) Air supplied	3·56 ,, ,, ,,	

Thinking that, in the above experiment, the fermentation of (*b*) had been promoted through the agitation occasioned by the current of air passed through the liquid, another experiment was made, in which air was bubbled through the one portion and hydrogen through the other. The following result was obtained :—

No Multiplication of Yeast Cells.

	I.	II.	III.
(*a.*) Stream of Hydrogen...	6·20	4·882	2·26 grms. dextrose decomposed.
(*b.*) ,, Air	7·38	5·289	2·45 ,, ,,

LONGEVITY OF YEASTS.

I may at this stage opportunely refer to some interesting results which have recently been obtained by M. Duclaux on the longevity of yeasts. M. Duclaux has had the unique opportunity of examining a number of the yeast cultures which were employed by Pasteur in his "Etudes sur la Bière," in the years 1873 and 1874, and he has not only determined whether these cultures still contained living yeast-cells, but also the proportion of alcohol, acid, &c., present in each, from which it is possible to draw conclusions as to the conditions which favour or militate against the preservation of yeast life. His results are summarised in the Table, p. 936.

From the Table it will be seen that age alone has had little or no effect in causing the death of the yeasts; for, of the six deaths, one actually occurred in the youngest culture, which was 11 years old, whilst the yeast in the oldest culture—17 years—was still alive. The principal cause which accelerates the death of the yeast appears to be the acidity of the medium, and, in all the dead cultures a considerable proportion of free acid was discovered, whilst in most, also, the amount of alcohol was particularly high.

The longevity of yeasts is of special importance in connection with the preservation of pure cultures of yeasts. It has been found by Hansen and Jörgensen that pure yeasts are best preserved in a 10 per cent. solution of cane sugar in distilled water. In such a solution the specific properties of the yeast remain unimpaired for years, whilst, if the yeast is preserved in wort-gelatin, its properties frequently undergo very serious alteration. I have also myself found that bacterial ferments are very liable to lose, more or completely, their fermentative power by continuous cultivation in a solid medium like gelatin; and

Parts per 1,000 C.C.

No.	Age in years.	Living = L. Dead = D	Liquid. B = beer. L = acid liquid.	Alcohol. (c.c.)	Maltose. (grms.)	Extract. (grms.)	Acetic Acid. (grms.)	Valeric acid. (grms.)	Total Acids. (grms.)
1	17		B	31·1	17·0	48·0	0·064	0·114	—
2	15·5		B	2·2	11·0	34·0	0·133	0·470	—
3	,,		B	3·0	—	58·0	0·163	0·427	—
4	,,		B	0·9	—	—	—	—	—
5	,,	L	B	—	—	—	—	—	—
6	,,		B	—	—	—	—	—	—
7	,,		L	—	—	—	—	—	—
8	,,		B	4·0	11·8	33·8	—	—	—
9	,,		B	—	—	—	—	—	—
10	,,	D	B	—	—	—	—	—	—
11	15·25		L	56·0	0·0	10·3	0·450	0	2·40
12	,,		L	—	—	—	—	—	—
13	15·75		B	—	—	—	—	—	—
14	,,	L	B	—	—	—	—	—	—
15	15		B	—	—	—	—	—	—
16	15·5		B	—	—	—	—	—	—
17	,,		L	46·0	11·4	—	1·500	0	3·96
18	,,	D	B	25·8	—	77·2	1·810	0	3·36
19	15		L	1·3	0·5	16·5	0·070	0	4·50
20	,,	L	B	21·5	—	20·0	—	—	—
21	11		B	2·0	—	21·7	—	—	1·15
22	,,	D	B	54·0	20·0	72·0	0·240	0	1·72
23	15		B	—	—	—	—	—	—
24	,,	L	L	52·0	1·0	7·0	0·094	0·028	1·92
25	16		B	30·4	6·0	42·0	—	—	—
26	14·5		B	—	—	—	—	—	—

sometimes this power is lost even by a single plate cultivation; and this is a point which all engaged in the study of fermentation phenomena should carefully bear in mind.

Behaviour of Yeasts under the Influence of Heat.

In connection with the remarkable vitality of yeasts, I may also refer to their behaviour under the influence of heat, as this has been recently made the subject of special investigation by Kayser. This investigation is the more welcome, as the previous information relating to this point is full of discrepancies and contradictions.

Kayser's experiments were made with a number of well-known yeasts in a state of purity, their resistance to heat being determined, both in the moist and dry condition, as well as in the form of spores. The results are summarised in the following Tables; in all cases the temperature indicated was maintained for a period of five minutes:—

Action of Heat on Yeasts and their Spores.

(*a.*) *In the Moist State.*

	45° C.	50° C.	55° C.	60° C.	65° C.
Yeasts.					
Bass..........	L L	L L	L L	L L	D D
St. Emilion ..	L L	L L	L L	D D	D D
Augustinerbräu.	L L	L D	D D	D D	D D
Hofbräu	L L	L L	D D	D D	D D
Spatenbräu	L L	L L	D D	D D	D D
Neunkirchen ..	L L	L L	L L	L L	D D
Sacch. Pastorianus	L L	L D	D D	D D	D D
Spores.					
Bass..........	L L	L L	L L	L L	L D
St. Emilion ..	L L	L L	L L	L L	D D
Augustinerbräu.	L L	L L	L L	L L	D D
Spatenbräu	L L	L L	L L	D D	D D
Sacch. Pastor. .	L L	L L	L L	D D	D D

N.B.—L = living, D = dead; two experiments were made at each temperature.

The principal points brought out by this Table are firstly that the low-fermentation yeasts are mostly more susceptible to heat than the high-fermentation forms, and, secondly, that although the resistance of the spores is greater than that of the vegetative cells, yet the difference in this respect is far smaller than that which generally subsists between bacilli and their spores.

ACTION OF HEAT ON YEASTS AND THEIR SPORES.

(*b.*) *In the Dry State.*

	Temperature necessary to destroy.	
	Yeasts.	Spores.
	deg. C.	deg. C.
Bass	95—105	115—125
St. Emilion	105—110	125
Augustinerbräu	—	115—120
Hofbräu	85—90	—
Spartenbräu	100—105	115
Sacch. Pastorianus	100—105	115

The Augustiner-yeast is so delicate that it does not stand the slightest heating in the dry state—in fact, it sometimes perishes during desiccation, even at the ordinary temperature of the air. The hardiest form in the dry state was the yeast of St. Emilion, which is a high fermentation variety obtained from wine.

In some cases, the remarkable phenomenon was observed, that the progeny of spores, which had resisted a high temperature, was endowed with the power of withstanding a temperature higher than was normal to the particular variety, thus affording evidence of the transmission of hereditary characters, which, as we have already seen, is such an important element in the case of these low forms, as well as with more highly organised forms of life.

CARBOHYDRATES FERMENTABLE BY YEASTS.

Much attention has from time to time been bestowed on ascertaining what carbohydrates are fermentable by yeasts, and great differences of opinion have frequently existed as to this point. Before it was possible to command pure cultures of yeast, the matter could not be investigated with any degree of precision, for ordinary yeast may contain numerous other organisms which, on the one hand, may transform some unfermentable carbodydrates into fermentable ones, whilst these other micro-organisms may themselves give rise to alcoholic fermentations which may be confounded with the alcoholic fermentation of yeast.. The older observers thus frequently record as fermentable by yeast substances which more recent, refined, and accurate experiments have shown to be unaffected by it when presented to them in a pure state. Until recently, it was generally recognised that the carbohydrates fermentable by yeast were—dextrose, lævulose, maltose, and cane-sugar (after inversion by the yeast itself), whilst opinion was much divided as to the fermentability of galactose. Recent experiments by Duclaux, Adametz, and Kayser have, however, shown that, although milk-sugar is not fermentable by the ordinary yeasts, there do exist one or more forms of yeast which have the power of setting up alcoholic fermentation in this carbohydrate. These milk-sugar yeasts, as we may call them, were obtained from a dairy in which much trouble had arisen through the fermentation of the milk. The action of these yeasts on various kinds of sugar has been compared with that of ordinary high fermentation brewers' yeast, and some very interesting differences between them have been brought to light. For not only have these milk yeasts the unique property of fermenting milk-sugar, but they are also far more effective than brewers' yeast in fermenting galactose, whilst, on the other hand, they are much inferior to brewers' yeast in bringing about the decomposition of maltose. The results shown in Table (p. 937) were obtained by Kayser.

In consequence of these new yeasts giving rise to a pure alcoholic fermentation of milk-sugar, it has naturally been suggested that by means of them a sparkling and highly nutritious alcoholic beverage might be prepared on a large scale from the whey which occurs as such an abundant by-product in the manufacture of cheese. The following figures show the composition of such whey-wine, as it may be designated, and which is said to resemble cider in flavour. To increase the alcoholic strength cane-sugar was added to the whey before fermentation; whilst on another occasion the expedient of concentrating the whey before fermentation was adopted; the latter method was, however, not found promising, as the taste was thereby rendered somewhat too saline :—

	Whey and Sugar.		Whey (concentrated).
	Yeast c.	Yeast c. + (Saccharomyces apiculatus).	Yeast c.
	per cent.	per cent.	per cent.
Residual Sugar	2·92	1·17	2·37
Alcohol, by weight	2·88	3·68	3·00
Acidity	·14	·15	·60

The possible extent of such an industry may be gathered from the recent statistics prepared by Rew, and which show that 224 millions of gallons of milk are annually used in the United Kingdom for the manufacture of cheese.

This fermented whey is, of course, an entirely different product from koumiss, which is the result of several concurrent fermentations in the milk; in all probability a lactic fermentation at the outset being followed by an alcoholic one subsequently.

Fermentation of Artificial Sugars.

The question of the fermentation of different sugars by yeast has acquired a particular importance and interest since the magnificent achievement of the preparation of artificial sugars by Emil Fischer. These researches are not only of profound interest from a purely chemical point of view, but also in their relationship to fermentation phenomena, and the light which they have thrown on the constitution of the several forms of sugar. Not only has Fischer succeeded in artificially preparing the two most important natural sugars, viz., dextrose and lævulose, but he has also produced in the laboratory sugars which either do not exist in nature or at any rate have not yet been discovered there. He has indeed excelled nature in the production of sugars, for whilst no natural sugar of the glucose-type contains more than 6 atoms of carbon, Fischer has synthesised sugars containing 7, 8, and 9 atoms of carbons respectively. It would be beyond the scope of these lectures to detail the beautiful and ingenious methods by which these bodies have been built up, but the matter is of so much importance to all interested in fermentation questions, that I feel constrained to review them very briefly.

The mere production of a sugar of the glucose type is not a matter of any great difficulty, it can be accomplished in essentially the same way as alcohol is converted into aldehyde, *i.e.*, by oxidation.

$$\underset{\text{(Alcohol)}}{C_2H_6O} + \underset{\text{(Oxygen)}}{O} = \underset{\text{(Aldehyde)}}{C_2H_4O} + \underset{\text{(Water)}}{H_2O}.$$

If, instead of taking ordinary alcohol, we take glycerin, and submit this to oxidation, we obtain a true sugar, capable of being fer-

Sugars.		Grms. per 1,000 c.c.				
		Sugar residual.	Sugar fermented.	Yeast produced.	Acidity.	
Milk-sugar, 60·30 grms.	*a**	25·60	34·70	·510	1·520	
	b	25·60	34·70	·270	1·050	
	c	21·40	38·90	·450	1·790	
Galactose, 36·80 grms.	*a*	16·80	20·00	·315	1·770	
	b	1·67	35·13	·480	1·100	**a* = Milk-sugar yeast of Adametz; *b* = Ditto, of Duclaux; *c* = Ditto, of Kayser.
	c	15·84	20·96	·270	1·280	
	m	20·80	16·00	·370	·790	
Glucose, 37·3 grms., initial acidity = ·180.	*a*	2·34	34·96	·590	2·030	
	b	·00	37·30	·215	1·370	
	c	·00	37·30	·485	1·740	*m* = Brewers' yeast.
Invert sugar, 56·80 grms.	*a*	2·22	54·58	·413	—	
	b	3·25	53·55	·240	—	
	c	2·79	54·01	·270	—	Acidity is expressed in terms of lactic acid.
Maltose, 89·3 grms., initial acidity = ·600.	*a*	73·76	24·54	·575	1·425	
	b	73·12	25·18	·395	1·480	
	c	74·40	23·90	·475	1·280	
	m	6·84	91·46	·735	1·830	

mented by yeast, and exerting the well known reducing action on Fehling solution :—

[Experiment.—Dissolve 10 grms. glycerin and 35 grms. soda crystals in 60 grms. warm water, cool down to temperature of room, and then add 15 grms. bromine. Shake: the bromine dissolves, and carbonic anhydride is evolved; the reaction is only complete in half an hour; but already after two minutes, the production of glycerose can be demonstrated. Take a portion of the liquid, decolourise with sulphurous acid, add excess of caustic soda, then heat with Fehling solution, the characteristic reduction of which at once takes place.]

The sugar thus obtained in an impure form contains only three atoms of carbon, and may be called glycerose $C_3H_6O_3$.

This triatomic sugar passes, however, spontaneously into a true hexatonic glucose :— $2C_3H_6O_3 = C_6H_{12}O_6$.

This hexatomic sugar is the starting point in the artificial preparation of the true sugars; the name of *α—acrose* has been given to it; and it is inactive towards polarised light. Before tracing its metamorphoses further, we must glance at a reaction which has proved of inestimable value in all investigations connected with the sugars, and has already taken its place beside Fehling's solution and the polarimeter in the sugar laboratory. I refer to the reaction between the sugars and the substance known as phenylhydrazine.

This substance readily enters into combination with divers sugars, forming compounds which can be easily purified, and which are particularly serviceable in the identification of different sugars. This substance, phenylhydrazine, may indeed be designated the Rosetta-stone of the sugars, having led, in the hands of Fischer, to the elucidation of the sugar-group, even as the famous stone led to the deciphering of the hieroglyphics in the hands of Egyptologists.

[Experiment.—Take solution of dextrose, add solution of phenylhydrazine hydrochloride, and sodium acetate, warm on water-bath, yellow precipitate of glucosazone.]

The following Table exhibits the value for purposes of diagnosis of these compounds :—

	Melting-point in Degrees C.	
Glucosazone	205 ..	lævorotary in glacial acetic acid.
Galactosazone	193 ..	inactive in glacial acetic acid.
Sorbinosazone	164 ..	ditto, ditto.
Lactosazone	200 ..	ditto, ditto.
Maltosazone	206 ..	ditto, ditto.
Arabinosazone	160 ..	inactive in alcoholic solution.
Xylosazone	160 ..	lævorotary in alcoholic solution.
Rhamnosazone	180 ..	ditto, ditto.
Gulosazone	156 ..	ditto, ditto.

But not only are these osazones of such importance in the diagnosis of sugars, but they have also been invaluable in the artificial synthesis of these bodies in consequence of the remarkable transformation which they undergo on treatment with strong hydrochloric acid. Thus

$$\underset{\text{(Glucosazone.)}}{C_6H_{10}O_4(N_2H.C_6H_5)_2} + \underset{\text{(Water.)}}{2H_2O} = \underset{\text{(Glucosone.)}}{C_6H_{10}O_6} + \underset{\text{(Phenylhydrazine.)}}{2C_6H_5N_2H_3}.$$

The glucosone on treatment with nascent hydrogen yields a sugar of the lævulose-type : –

$$\underset{\text{(Glucosone.)}}{C_6H_{10}O_6} + \underset{\text{(Hydrogen.)}}{H_2} = \underset{\text{(Glucose of lævulose type.)}}{C_6H_{12}O_6}.$$

Equipped with a knowledge of these changes, we can now attempt to study the Table on p. 940, which indicates the several steps which have led to the artificial preparation of the well-known sugars, dextrose and lævulose.

The beautiful symmetry of this series of reactions cannot fail to appeal to all, but no one excepting the chemist can adequately appreciate and admire the marvellous ingenuity of the design and the brilliant experimental skill demanded for its execution and accomplishment.

We now not only understand the chemical difference between dextrose and lævulose, which had previously been explained by Kiliani's formulæ :—

CH$_2$OH. CHOH. CHOH. CHOH. CHOH. CHO.
Dextrose.

CH$_2$OH. CHOH. CHOH. CHOH. CO. CH$_2$OH.
Lævulose.

But we have through Fischer's researches been supplied with the true optical isomer of dextrose, *i.e.*, a lævorotary glucose, as well as the optical isomer of lævulose, *i.e.*, dextro-rotary lævulose.

This dextro-rotary lævulose is obtained, as shown in the diagram, by fermenting the artificial and inactive fructose with brewer's yeast, in which fermentation the yeast cells single out the ordinary lævulose molecules, decomposing them into alcohol and carbonic

α-ACROSE (from Glycerose)

i-Glucosazone (by union of α-Acrose with phenylhydrazine)

i-Glucosone (by action of strong hydrochloric acid on *i*-Glucosazone)

i-Fructose (by action of nascent hydrogen on *i*-Glucosone)

(by fermentation of *i*-Fructose with brewers' yeast)

l-Fructose

(dextro-rotary)

i-Mannite (by action of nascent hydrogen on *i* Fructose)

i-Mannose (by oxidation of *i*-Mannite)

i-Mannonic acid (by further oxidation of *i*-Mannose)

(by crystallisation of strychnine salt this decomposes into)

l-Mannonic acid.

l-Gluconic acid (by heating *l*-mannonic acid with quinoline)

l-Glucose (by reduction of *l*-gluconic acid with nascent hydrogen)

d-Mannonic acid.

d-Mannose (by reduction of *d*-Mannonic acid with nascent hydrogen)

d-Glucosazone (by union of *d*-Mannose with phenylhydrazine)

d-Glucosone (by action of strong hydrochloric acid on *d*-Glucosazone)

d-Fructose (by action of nascent hydrogen on *d*-glucosone)

Lævulose (laevo-rotary)

d-Gluconic acid (by heating *d*-Mannonic acid with quinoline)

d-Glucose (by reduction of *d*-Gluconic acid with nascent hydrogen)

---

acid, whilst the dextro-rotary lævulose molecules, which are an entire novelty, and of which the yeast organisms and their ancestors have no experience in the past, remain untouched by them. This phenomenon is particularly noteworthy, as being the first instance in which the capacity of yeasts to select between two optical isomers has been put to the test. Indeed, this is the first instance of optical isomerism in the sugar-group at all.

We must now turn to the second group of recent discoveries in the department of the sugars, which includes the synthesis of sugar containing more than the six atoms of carbon which we find in the natural sugars.

The fascinating problem of thus building up sugars of greater molecular magnitude, really depends upon chemical reactions of great simplicity, and which a few minutes attention will render fully intelligible.

Any of the sugars, whether of the dextrose or lævulose type, can combine with hydrocyanic acid to form an oxycyanide in the same way that ordinary aldehyde and acetone do.

$$\underset{\text{(Aldehyde)}}{\begin{array}{c} CH_3 \\ | \\ CHO \end{array}} + \underset{\text{(Hydrocyanic acid.)}}{HCN} = \underset{\text{(Oxycyanide.)}}{\begin{array}{c} CH_3 \\ | \\ H\text{—}C\text{—}(OH) \\ | \\ CN \end{array}}$$

$$\underset{\text{(Acetone.)}}{\begin{array}{c} CH_3 \\ | \\ CO \\ | \\ CH_3 \end{array}} + \underset{\text{(Hydrocyanic acid.)}}{HCN} = \underset{\text{(Oxycyanide.)}}{\begin{array}{c} CH_3 \\ | \\ C\langle\begin{smallmatrix}(OH)\\(CN)\end{smallmatrix} \\ | \\ CH_3 \end{array}}$$

These oxycyanides, by treatment with caustic alkalis, yield the corresponding oxy-acids:—

$$\begin{array}{c} CH_3 \\ | \\ H\text{—}C\text{—}(OH) \\ | \\ COOH \end{array} \quad \text{and} \quad \begin{array}{c} CH_3 \\ | \\ C\langle\begin{smallmatrix}(OH)\\(COOH)\end{smallmatrix} \\ | \\ CH_3 \end{array}$$

Applying these reactions to a typical case in the sugar-group, we will take dextrose:—

$$\underset{\text{(Dextrose)}}{CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHO.}$$

$$+ \underset{\text{(Hydrocyanic acid)}}{HCN.} = \underset{\text{(Oxycyanide)}}{CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CH\begin{cases}(OH)\\(CN)\end{cases}}$$

from which is obtained the corresponding oxy-acid:—

$$CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ COOH$$

and from this, by reduction with nascent hydrogen (sodium amalgam), is then obtained the corresponding sugar:—

$$CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHOH.\ CHO$$

containing 7 atoms of carbon, and which we may call *heptose*. From this heptose we can pass by similar reactions to a sugar containing 8 atoms of carbons, or *octose*, and from this, again, to one containing 9 atoms, or *nonose*. This is as far as the synthetical method has hitherto been carried, but there is no reason why it should not be possible to pursue the same processes even much further.

Now these substances are of more interest from a physiological than a chemical point of view, and already experiments have been made in order to ascertain the attitude of yeast towards them. The results in this direction are extremely remarkable, showing that those sugars are fermentable which contain 3, 6, or 9 atoms of carbon, whilst the remainder are, without exception, unfermentable.

In concluding this part of the subject, I may fittingly draw your attention to the magnificent collection of sugars which science has revealed up to the present time.

TRIOSE.
$C_3H_6O_3$ .. Glycerose.

TETROSE.
$C_4H_8O_4$ .. Erythrose.

PENTOSE.
$C_5H_{10}O_5$ { *Arabinose.
*Xylose.
*Rhamnose ($CH_3.\ C_5H_9O_5$)

HEXOSE.
$C_6H_{12}O_6$ .. Glucose, *d**, *l*, *i*.
Mannose, *d*, *l*, *i*.
Fructose, d*, *l*, *i*.
Gulose, *d*, *l*.
Galactose, *d**, *l*, *i*.
*Sorbinose.
*Formose.
β–Acrose.
Rhamnoheptose ($CH_3.\ C_6H_{11}O_6$).

HEPTOSE.
$C_7H_{14}O_7$ .. Mannoheptose.
Glucoheptose.
Galaheptose.
Fructoheptose.
Rhamnoheptose ($CH_3C_7H_{13}O_7$)

OCTOSE.
$C_8H_{16}O_8$ .. Mannoctose.
Glucoctose.

NONOSE.
$C_9H_{18}O_9$ .. Mannononose.

N.B.—In the above Table *d* = dextro-rotary, *l* = lævo-rotary, *i* = inactive to polarised light.

Of the 31 sugars in this Table, all, excepting 8, are the direct result of the indefatigable zeal and genius of Emil Fischer.

Miscellaneous.

JAPANESE CERAMICS.

The French Chargé d'Affaires at Tokio says, in his last report, that the most ancient type of Japanese ceramics known is the *Kaizuka-doki*, of which specimens have been found at Omori and its environs. The articles themselves are heavy and clumsy, and the decorations, which are very primitive, are confined, in the majority of cases, to a few lines, curves, or crosses. In the porcelain known as *Iwaibe-doki* a decided improvement is shown, and the same may be said of Corean pottery. Several articles of this description of pottery, presenting the characteristics of solidity and finish, are frequently met with in the tombs of the first emperors. One of the latter, Suimin, who reigned at the earlier period of the Christian era, favoured with his patronage a celebrated Corean potter, named Koki, who came to Japan about that time. In 649 A.D. an edict of the Emperor Kotoku decreed that taxes might be paid in porcelain, and this gave a decided impetus to the production; from the tenth to the fifteenth century, however, the incessant civil dissensions kept the ceramic art in a condition of depression, from which it only commenced to recover in 1598, the year in which Hideyoshi brought back from his travels in Corea potters from that country, who established themselves in his dominions. The first attempt at exportation was made in 1646; and about seventy years later two potters, in spite of the interdiction against foreign travel, left secretly for India, where they sold considerable quantities of porcelain, which in all probability consisted of inferior Imari and Nabeshima ware. These men, however, paid for their temerity with their lives, as they were thrown into prison on their return, where they committed suicide to escape their punishment. It was only in 1842 that the export of porcelain was seriously engaged in, and the trade has continued up to the present day.

Statistics assign to porcelain the seventh place in the list of exports from Japan; but when it is considered that the articles which precede it are, for the most part, raw materials and articles of consumption, such, for example, as silk, cereals, tea, coal, products of the sea, and metals, it will be seen that porcelain holds the first place in home-manufactured articles. Mr. Hosoki, professor of the Technological School, at Asakusa, has recently pointed out, in a dealing with this particular branch of national production, the advantages that would be derived in extending the relations with North America. According to him, the States of the American Union, whose demands for Japanese porcelain have increased threefold during the last five years, are destined to become the principal export market for these articles. It is true that, at present, Japan only furnishes about two per cent. of the porcelain and faïences imported into the United States; but the opening of a canal across Central America, which will allow of goods coming directly to North American ports situated on the Atlantic, will considerably increase the trade. To keep pace with the times, Mr. Hosoki has made many suggestions and recommendations, among them being one for the substitution of carbonate of lime for wood ashes (*Isu-bai*) in the glazing of the porcelain. The Isu tree which grows at Kinshin, supplies the finest quality of this vegetable ash, but on account of the increasing demands, it is becoming rarer and dearer each year. The important element of this ash is carbonate of lime, which abounds in a natural state in many parts of Japan, and at a fifteenth part of the cost. Experiments which have recently been made at the Technological School of Asakusa, have proved that its use would diminish, by two-thirds at least, the cost of glazing, and would effect, out of the 100,000 piastres annually expended in the purchase of this vegetable ash, a saving of about 70,000 piastres. The porcelain workers would also reduce their expenses very considerably by substituting charcoal for the pine wood now used for the baking, and also by a more general adoption of improved machinery. Mr. Hosoki is of opinion that the abundance of kaolin throughout the empire, and the artistic aptitudes of the Japanese people, will certainly contribute to render the ceramic industry one of the chief sources of wealth in the country. The Mino porcelain consists of twenty-six different varieties; the best known is the blue and white, which has the largest sale on the home markets and in China. Unfortunately, the necessity of producing in large quantities and at a cheap rate has adversely affected the value of this article. The sale abroad of Kutani porcelain and faïences realises annually about 180,000 piastres, but here, again, the quality has deteriorated. In 1888, the latest year for which the statistics are available, the number of factories engaged in making porcelain was 4,788; the number of workmen employed, 26,762. The articles made numbered over 126,000,000, and the value exceeded 2,000,000 piastres.

RUSSIAN TRADE ASSOCIATIONS.

There are only two kinds of association in Russia for labour purposes—(1) the Association of Artisans and (2) the Artels. The artisans have a particular organisation of their own, and their own especial institutions, for the purpose of safeguarding their interests. Her Majesty's Secretary of Embassy at St. Petersburg says that in that city their number amounts to about 60,000, and they represent one-eleventh of the entire population. These associations in St. Petersburg are about eight in number, and comprise about twenty-five different trades. Each association has its own bureau, composed of three representatives and a secretary, which forms its executive committee. A list is kept containing the names of all the members of the association, their families, and all the necessary information respecting their station. The committee is charged with the duty of settling all differences that may arise, fixing penalties, distributing the common funds, helping the poor and sick, and exercising control over the work in the workshops, the foremen, and apprentices. The committee is obliged to execute the orders of another body, which represents the whole of the artisan class, and which is composed of a president, the heads of all committees, and the delegates from every association. The president of this central committee has to control the acts of the smaller committees, he has to visit the workshops, take measures to preserve order and discipline, inspect the registers, see that the apprentices are well treated, and that relief is granted to the sick, the widows, and orphans. All the members of each association meet once a year, and oftener if necessary, to elect their executive committees, settle the amount each incoming member must pay, and discuss the budget. The executive committees also meet together once a year to discuss the affairs which touch the interests of the whole body of artisans. The "artel" is the only other form of association to be met with in Russia. It is peculiar to the country, and is to be found in every branch of industry. It is based rather on local customs than any special regulations. The primitive form of the institution is an association of workmen who live together, feed together, and work together, and on the termination of each piece of work divide the profits amongst themselves. Labour, therefore, was the primary motive of the formation of the artel, which as soon as capital made itself felt and workmen began to make engagements with a contractor, and receive from him monthly wages, was destroyed. Like the Mir or Commune, the members of the artels have an equal share in the profits, and stand under the direction and authority of a foreman or elder. In the larger towns the artels are of a much more complex kind, possessing a large capital and pecuniarily responsible for the acts of the individual members. Such, for instance, are those of the bank porters, who have unlimited opportunities of stealing, and are often entrusted with the care and transport of enor-

mous sums, but the banker has no cause for anxiety because he knows that if any defalcation occurs it will be made good to him by the artel. The artel being responsible for the individuals of which it is composed, is very careful in admitting new members, and a man when admitted is closely watched, not only by regularly constituted office bearers, but also by all his fellow members who have an opportunity of observing him. It is not surprising therefore, that this kind of artel is to be met with in a great number of industries in Russia, so that the term arteltchick (member of an artel) now stands for that of a clerk. There are various sorts of artels; they are to be found in the country, where the peasant, who is too poor to cultivate purchased or leased lands, forms with other peasantry in the same condition as himself, an artel, and cultivate it in common, dividing amongst themselves the profits of their labour. The oldest is generally chosen as chief, and the work is subdivided according to each man's physical force. There are artels of shepherds who are hired by the commune, but generally paid in kind. Everything that they receive is put by into one common store, and then sold. There are artels in the postal service, among peasants who furnish horses and vehicles, and artels of itinerant carpenters who, however different their wages may be, divide everything in common among themselves. Generally speaking, the artels are divided into four distinct classes:—(1) Industry, (2) credit, (3) food, and (4) insurance. The artels for credit are somewhat rare, owing to the fact that the Russian workman seldom puts by any money, and when he does is deterred, by reasons of fear, from lending it to any association. On that account the Government, the local authorities, landed proprietors and owners of factories, have interested themselves in this direction by advancing capital for the purpose of forming savings' banks.

THE ITALIAN SALT MONOPOLY.

A report has recently been prepared for the *Bulletin de Statistique et de Legislation Comparée* by M. Castorina, an Italian Government official, upon the subject of the salt monopoly in Italy. It appears from this report that the Italian Treasury obtains annually a revenue of about £2,080,000 from this source. The State owns ten salt mines or marshes, those of Cervia, Comacchio, Corneto, Tarquinia, Lungro, Margherita di Savoia, Portoferraio, Salsomaggiore, San Felice, Cagliari, Carloforte de Sardaigne, and Volterra. The salt works of Salsomaggiore, San Felice, Cagliari, and Carloforte de Sardaigne are conceded to private persons or companies, who pay an annual sum to the Government. The method of production employed in the salt works varies according to district and the nature of the product. At Lungro, where rock-salt abounds, it is worked with the pick; but this system could not be adopted in places where the layers of salt, unequally distributed in the subsoil, would not bear the expenses of the working. At Salsomaggiore, as well as at Volterra, the water which filters through the soil penetrates through the salt beds, dissolves them, and falls, loaded with salt, into wells, from which constant supplies are drawn. The salt obtained in this manner, from salt water evaporated by the action of fire, is much superior to the sea salt. The other State salt works are all situated on the sea coast, and the methods of production only vary in very slight proportions. In salt marshes, it is of importance that evaporation should be obtained by natural heat, and as rapidly as possible. The salt marshes which are farthest south are much the best, and in those districts where a clear sky and dry air are not favourable to the action of the solar rays, the working is carried on with some difficulty, and it frequently happens that rain comes to spoil the harvest before the salt is completely deposited. Italy is very little behind other countries from the point of view of the abundance and purity of the product. The cost price of the salt varies between a maximum of 2s. 6d. and a minimum of 5d. per 100 kilogrammes. The salt works of Cervia are situated in the province of Ravenna, and are about 5,880 metres long and 2,130 metres wide. The production of salt at Cervia amounted, during the year 1890-91, to about 19,000 tons. The Comacchio salt works are about four kilometres from the town of the same name, near the mouths of the Po, and not far from the port of Magnavacca. The working dates from an early period, and it was in 1810 that the Comacchio salt commenced to supply the requirements of Venetia, of Lombardy, and even of central Italy, where it was sent by river, this being the surest and most economical method of transport. In 1885 these salt works only produced about 10,000 tons, but this quantity has since increased to 27,000 tons, owing to the improvements effected in the basins. The salt works of Corneto Tarquinia, situated on the coast of the Mediterranean, a few miles to the north of Civitavecchia, date back to the year 1805. These works are among the most productive in Italy, the average yield per hectare being three times greater than that of the Cervia works, and about equal to that of Comacchio. The annual product is about 5,000 tons of good salt for consumption. The mineral salt works of Lungro, a small commune of Castrovillari, in the province of Cosenza, situated about 410 metres above the level of the sea. The surface of this mine worked is about 32 acres in extent, divided into five series of excavations according to the depth of the workings. The production, which naturally varies with the richness of the beds, amounted to over 6,000 tons in 1890-91. The Margherita di Savoia works are situated on the borders of the Mediterranean, on the south-eastern point of the province of Foggia, and the quantity of salt produced in 1890-91 exceeded 43,000 tons. The

Portoferraio works for the production of sea salt are in the neighbourhood of the place from which they take their name, and were established by the Grand Duke of Tuscany, with the double object of improving the marshy lands, and of procuring work for the natives of the Isle of Elba. The product is about 3,000 tons annually. The Volterra works are at the west of the town of the same name. This establishment is fed by the water of certain natural wells, known as *mojes*, from which the salt water is continually flowing. The salt works of Cagliari and Casloforte, in Sardinia, are, as regards the quantity and quality of their products, the most important in Europe. The first is situated at a distance of about three miles from Cagliari; a narrow canal of about 600 or 700 metres in length connects it with a large pond, which in its turn communicates with the sea. This pond constitutes the true wealth of the Cagliar salt works. Of somewhat minor importance are the works of Carloforte, and the total product of Cagliari and Carloforte amounts on an average to about 130,000 tons. The Salsomaggiore works are about nineteen miles from Parma and five from Borgo-San-Domino, and the quantity of salt produced is only about 500 tons annually, which is principally used for salting provisions. The San Felice works are about six miles from Venice, and are some of the largest in the kingdom, although they only produce about 7,000 tons of salt annually.

THE CULTIVATION AND PREPARATION OF VANILLA.

Notwithstanding the various preparations that have lately been put upon the market as substitutes for the vanilla for flavouring purposes, a great deal of attention is still directed to the cultivation of the plant, and the preparation of the fruits for commercial purposes. Perhaps the most recent and formidable rival in the cultivation of vanilla is Fiji, from whence some good samples have more than once been received. The first consignment sent to London brought from the consignees a very congratulatory report on the prices realised, namely, 22s. 6d. per lb. for three-fourths of the consignment, and 21s. 6d. for the remaining fourth. The consignees further say that "unless the quality had been very satisfactory no such price could have been obtained, and if further consignments are up to the quality now sent in, we can say that Fijian vanillas will command a good price and a great sale. Speaking from an experience of nearly forty years, during which we have handled a considerable quantity of vanillas, we can unhesitatingly say that the quality of that sent here is equal to any vanilla grown in the Mauritius or elsewhere. The beans are plump and well cured, and are beginning to throw out splendid crystals. In future consignments it will be necessary to sort the vanillas and tin them according to lengths, and to take care not to pack the tins too closely."

In connection with the subject of the preparation of vanilla for market, one of the most striking departures from the ordinary mode of drying the pods seems to be that of keeping them moist or rather wet, for some sample pods have recently been received in London preserved in alcohol. They are described as of fine appearance and good aroma, though, of course, partly exhausted by the action of the spirit, which, it has been suggested, will probably be sold with the beans. It is said "that by placing the pods in alcohol when freshly gathered, a much more fragrant tincture is obtained than by exhausting the cured beans purchased in Europe."

Obituary.

Duke of Sutherland, K.G.—By the sudden death of the Duke of Sutherland at Dunrobin Castle, on Thursday, 22nd inst., the Society of Arts loses a prominent member of nearly 40 years standing. He was elected in 1853, and filled the office of vice-president in the years 1864-65 and 1879-82. It is not necessary here to give particulars of the duke's life, which are fully described in the daily papers, further than to note that he was born in 1828, and succeeded his father, as third Duke of Sutherland, in 1861. Of the duke's occupations as a landowner, the writer of the obituary notice in *The Times* says:—"There are two spheres of work in which he made for himself a reputation, which may quite fully be described as unique. They were the reclamation of waste lands and the extension of railways and railway traffic in the northern counties of Scotland."

Dr. G. D. Longstaff.—George Dixon Longstaff, M.D., who died at his residence, Butterknowle, Wandsworth, on Friday, 23rd inst., in his 94th year, had been a member of the Society of Arts since 1855. He graduated M.D. at Edinburgh University in the year 1828, where he was for some time assistant to Dr. Hope, Professor of Chemistry. In that capacity he is said to have been the first teacher of practical chemistry in this country. He practised as a physician at Hull, and then spent some years in America. Upon his return to England he interested himself in mercantile affairs. Dr. Longstaff was an active supporter of Wilberforce's anti-slavery movement. He was one of the founders and a vice-president of the Chemical Society of London, and for many years he was chairman of the Royal Maternity Charity. He had resided in the parish of Wandsworth for upwards of 50 years, and was one of the first members of the Wandsworth District Board of Works. Dr. Longstaff was an occasional contributor to the *Journal*, and he held the office of treasurer to the Society from 1863 to 1865.

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Chicago Exhibition, 1893.

REPORT ON THE PROGRESS OF WORK.

The following report on the progress made in the work and preparation for the Columbian Exposition at Chicago has been transmitted to the Foreign Office by Colonel Hayes Sadler, H.B.M. at Chicago. It is dated September 1, 1892, and gives a very full account of the progress made to that date :—

Appearance of the Grounds.

Now that the principal constructions of the World's Columbian Exposition approach completion, the exterior of nearly all being finished, while the grounds around them are already, in a great measure, laid out, it is possible to form a general idea of the effect which will be presented when the Exhibition opens to the public on May 1 next year. The beauty of the scene can scarcely be exaggerated, and when the object and size of the immense buildings, which are all of classical design, with the vast extent of ground they occupy, are considered, it is difficult to imagine a more perfect arrangement than has been planned. A peculiar feature is the harmony which unites the various buildings, designed by different architects, into one artistic panorama; and to this the site on the borders of Lake Michigan lends a natural perfection. Lagoons and canals everywhere intersect the grounds, and the irregularity of outline of these water spaces, and of the wooded island in their midst, contrasts charmingly with the long straight lines of architecture which are thus thrown with somewhat irregular disposition. The effort so successfully carried out will, undoubtedly, exercise a powerful influence on artistic feeling in the country; and even were no exhibits of matured excellence to be seen within, the buildings cannot fail to stimulate the development of taste, and guide towards perfection in art in the New World. The main object of the Exhibition is far more material, but to this nothing will be lost by added charm of artistic beauty and grandeur. The extent of the grounds and size of the buildings have been described in a previous report. Some idea of the vastness of the undertaking may be formed by comparison with the Exhibitions of Paris, in 1889, and of Philadelphia, in 1876, as follows :—

		Paris.	Centennial.	Chicago.
Area of grounds	Acres	238	284 49	633
„ buildings	„	75·5	70·08	142·12
Cost of „	Sterling £	720,752	1,037,966	1,457,206

The approximate exhibit space at Philadelphia was 4,323,330 square feet, and at Chicago it is estimated at 9,138,888 square feet.

Progress in Construction.

The work of construction progressed satisfactorily during the early part of the year, there having been few days when operations were checked by severe weather, but it was much retarded by heavy rains in May and June. The rainfall in June was 10·58 inches, and work was interrupted for 18 out of 30 days, foundations were flooded, and the underground work of laying pipes suspended, while some slight damage was done by severe storms of wind. When possible, the full force of 7,000 men was employed, but not so much work was accomplished during those two months as had been counted on, and at the end of June the two great buildings, the Manufactures and Liberal Arts and the Mines and Mining, presented a very unfinished appearance. In July, however, on a change of weather, extra hands were put on, and such progress was made that no fear is now entertained but that these buildings also will be completed in time for the dedication on October 21.

The condition of the principal buildings at the end of July was as follows :—

In the Administration Building the construction is complete, and all staff work placed. The dome framework is erected and covered in, but gilding and decoration has not yet commenced. The statues are being cast for the interior, many for the exterior being finished, though not yet in place.

The Mines and Mining Building is com-

plete, but it will probably receive another coat of colouring.

The Electricity Building is finished as far as ironwork and woodwork are concerned. The staff on the north and east sides is placed, and on part of the west side.

The main part of the Transportation Building is practically complete, but the Annex has yet to be built.

The Horticultural Building is entirely finished, with the exception of some of the sculptured groups to be placed outside.

In the Women's Building little remains to be done but interior decoration. The outside sculpture work on the pediment is progressing.

In the Fisheries Building the imitation Spanish tile roofing is all in place; the concrete work of the aquarial tanks and fountain is nearly finished. The ornamental staff work outside and on the north and south entrance loggias is all complete.

In the Art Gallery the iron contractors have finished their work on the dome; nearly all the masonry work is done, and nearly all work on the building completed. Plain and ornamental staff on the north side and entrance on the east end is placed, and three-quarters of the ornamental and half of the plain staff placed on the south side and entrance.

In the Manufactures and Liberal Arts Building all the 22 large trusses are up, and the diagonal and smaller trusses placed on the south end. The traveller will shortly be moved to put up smaller trusses on the north side. Skylights in the wood-covering are in course of placing; where there is no skylight the wood will be covered with canvas. The side trusses are placed on the west and east and partly on the south sides, and the roofing of the naves is erected. The staff is placed on the north-east and north-west pavilions, wood and staff work progressing in other parts. The amount of steel work erected to end of July was 9,539,000 lbs. out of 12,000,000 lbs. required; lumber, 13,784,288 feet, out of a total required of 17,000,000 feet. The central hall of this building is 1,280 feet by 380 feet; a nave 107 feet wide runs round the whole building, and the entire length of the building, with the strip running between the central hall and the nave, is 1,687 feet, and the width 787 feet. The highest part of the dome is 245 feet. There are 4,000,000 feet of lumber in the foundation, not including the piles, and 3,000,000 feet (200 cars loads) in the floor. It is three times the area of St. Peter's at Rome, and four times as large as the Colosseum.

In the Machinery Hall the iron work on main buildings is complete, except the central dome. Carpenters are sheathing the east end and working on the roof. All the staff work is placed on the north side of the Annex, and three-quarters of the ornamental staff placed on the west end. Groups of statuary for the outside of main buildings are being made, and some figures are in position on ridge line of roof.

The Forestry Building is roofed and nearly finished, the rustic colonnade is almost completed, and the rustic trimmings are all in place on both interior and exterior of window and door frames. Split oak shingles are now being placed on the roof.

The main Agricultural Hall is done except interior trim and placing statuary. Some statues have already been placed and decorative fresco work started in the loggias. The roof joists of the Annex have been set, structure entirely sheathed in, and staff work advancing; canvas and metal roofing finished.

The Dairy Building is wholly finished.

With the exception of manufactures and machinery, all the above buildings are roofed and windows glazed, and comparatively little remains to be done but interior decoration. All will be coloured with a light tint of old ivory or cream, varying somewhat in the different constructions; the tinting, which is finished on some of the buildings, is effected by means of a liquid spray, composed chiefly of oil and colouring matter. The statues are moulded of staff (on a light framework of wood), the same material as is used for covering the outside of all the buildings.

The central dome of the Government Building is sheathed in, and the corrugated iron covering is being replaced. All the building is covered with staff and practically finished, except interior trim. The estimated cost, with the Annexes for the army and weather bureaux, is £78,577, and the whole expenditure contemplated by the Government is £300,000.

The Illinois State Building is an imposing structure. Rough work is all done except on the dome, the plastering of the exterior nearly finished, exterior covering being placed on all sides of the building. There are 22 other State buildings in course of construction, some of them being far advanced, namely, Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Delaware, Maryland, Michigan, Wisconsin, Indiana, Ohio, Colorado, Cali-

fornia, Nebraska, Kansas, Iowa, Missouri, West Virginia, Minnesota, and Montana. These are all grouped at the northern end of the park on the separate ground allotted them, and are of great variety of design; many are important buildings, and will present a charming effect.

The following foreign countries will erect buildings:—Great Britain, Canada, Ceylon, Germany, Japan, Argentine Republic, Austria, Brazil, Costa Rica, Colombia, Chile, Ecuador, France, Guatemala, Hayti, Mexico, Nicaragua, Norway, Sweden, and the Hawaiian Islands, also the State of Rio, Brazil. Others may yet decide to do so.

The British Building was the earliest foreign construction commenced, the first pile having been driven three months since on the small but beautiful site allotted on the shore of Lake Michigan, to the north-west of the United States Building. The walls are constructed to the first floor, and flooring laid, but otherwise not much progress has been made, work having been delayed owing to non-arrival of detailed plans, and delay in delivery of material. Plans for the German, Ceylon, and Swedish Buildings have been accepted and ground allotted. The Ceylon construction will be in the form of a Ceylonese Court; the Swedish Building, of the old Swedish Cathedral style, is to be constructed entirely in Sweden, and shipped in sections, and will cover 12,000 square feet.

[*To be continued.*]

Proceedings of the Society.

CANTOR LECTURES.

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By Percy F. Frankland,
Ph.D., B.Sc.(Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

Lectnre IV.—Delivered May 23, 1892.

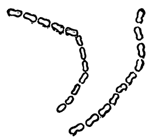
Bacterial Fermentations.

The fermentation phenomena induced by yeast, although of such enormous importance from a practical, commercial, or pecuniary point of view, are comparatively tame and uninteresting from the theoretical side, as compared with the varied changes which result from the vital activity of other micro-organisms. Whereas, in the case of yeasts, the number of substances acted upon is extremely limited, including only a few of the sugars, and the products of fermentation almost confined to alcohol and carbonic acid, in the fermentations induced by bacteria, on the other hand, not only are the substances attacked immensely more numerous, including both organic and mineral bodies of the most varied composition and constitution, but the products of fermentation are also greatly more diversified.

A great many of the investigations of these bacterial fermentations were made before the introduction of those exact methods for the study of micro-organisms, to which I referred in my first lecture, so that they require practically in all cases a reinvestigation on a more sound basis. Much has already been done in this direction, but it is a mere fraction of what still remains.

Of these bacterial fermentations, the one which has longest been industrially recognised is the acetic or vinegar fermentation, the exciting cause of which was found by Pasteur, in 1864, to be an organism which, owing to its forming a skin on the alcoholic liquid, he named "mycoderma aceti," and which formerly had been known as "Flowers of Vinegar." He further showed that this microbe per-

Fig. 18.



Mycoderma aceti.

forms the function of an oxygen-carrier in the reaction, and that if its vitality is impaired, aldehyde, instead of acetic acid, makes its appearance, whilst, if the fermentation is allowed to continue after the whole of the alcohol has been transformed, then the acetic acid itself falls a prey to the oxidising power of the organism, and is converted into carbonic acid and water.

Our knowledge of this remarkable and important fermentation has recently been greatly extended by Adrian Brown, who has shown that normal propyl alcohol can be oxidized by the mycoderma aceti to propionic acid, whilst methyl alcohol, isoprimary butyl alcohol, and amyl alcohol, are all unaffected by it.

This mycoderma aceti is also able to exert its oxidising powers on some polyhydric alcohols and on some of the sugars; thus,

with glycol it forms glycollic acid; with glycerin, on the other hand, the oxidation is complete, carbonic acid and water being formed; with mannite, lævulose is formed; whilst with dextrose the result is gluconic acid. On cane-sugar it has no action, nor on dulcite or erythrite.

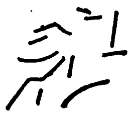
Brown has also extended his investigations to the origin of the tough gelatinous mass which is often found on the vessels employed in the manufacture of vinegar, and which generally goes by the name of "vinegar plant," or "Mother of Vinegar." This material is found to be cellulose, and is produced by an organism closely resembling the mycoderma, but differing in the possession of the distinctive property of producing this jelly-like substance from either dextrose, lævulose, or mannite, but especially from lævulose. These transformations by the *bacillus xylinus*, as this organism has been named, from its power of building up woody fibre or cellulose, are of great theoretic interest.

Another very familiar and ancient fermentative change, which is much feared in many industries, is the so-called lactic fermentation, which takes place so readily in milk, and which consists in the conversion of the various kinds of sugar—generally milk-sugar—into lactic acid. This has also been the subject of several recent investigations. In the ordinary lactic fermentation induced by the bacillus, which has been very thoroughly investigated, more especially by Pasteur, Lister, and Hueppe, the lactic acid formed is inactive towards polarised light. Quite recently, however, another lactic fermentation has been discovered by Schardinger, induced by a totally distinct organism, and the lactic acid formed in this case is active, but, unlike the active lactic acid found in muscular tissue, it is lævorotary, instead of dextrorotary. On mixing equal quantities of these two active lactic acids in solution, the ordinary inactive lactic acid is obtained. The optical isomers predicted by theory, and of which the dextrorotary isomer has been well known since the classical researches of Wislicenus, are now completed through the discovery of this fermentation product. In fact, all three optical isomers are obtainable by fermentation, the lævorotary form by Schardinger's organism, and the dextrorotary one by an organism found by Nencki and Sieber.

Chemical science is, in fact, continually becoming more and more indebted to the work of micro-organisms, which are becoming indispensable reagents in the chemical laboratory, as it is only by their intervention that many substances are accessible. Their utility to the chemist depends generally upon their remarkable power of differentiating between closely similar substances. We have already noticed how differently the several members of the sugar-group are affected by yeasts, some sugars undergoing ready fermentation by some particular form of yeast, whilst other sugars obstinately resist such decomposition. Similar phenomena of an equally remarkable character occur in connection with the bacterial fermentations.

Of this power of differentiation possessed by micro-organisms, I will bring before you an example which has recently occupied much of my attention in connection with a fermenting organism which I discovered some years ago, and to which I have given the name of *Bacillus ethaceticus*, in consequence of its decomposing a number of substances with formation of ethyl alcohol and acetic acid as the principal products.

FIG. 19.



B. ETHACETICUS (Percy Frankland).

The caprice of this bacillus was first manifested in its attitude towards two substances which are both chemically and physically very closely allied, viz., mannite and dulcite. Thus:—

	Mannite.
Occurrence	Numerous plant juices.
Taste	Sweet.
Melting-point	166° C.
Crystalline form	Large rhombic prisms.

	Dulcite.
Occurrence	Numerous plant juices, but less frequently.
Taste	Sweet, but less so.
Melting-point	188° C.
Crystalline form	Large monoclinic prisms.

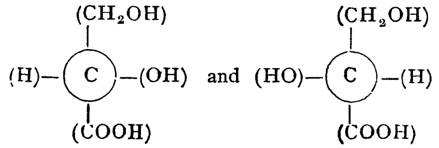
Chemically they are still more similar, for one and the same formula has to do duty for both of them, thus:—

$C_6H_{14}O_6$ or $CH_2OH.\ CHOH.\ CHOH.\ CHOH.\ CHOH\ CH_2OH.$

Under these circumstances, it might have been anticipated that micro-organisms would adopt much the same attitude towards each of these substances, but, as a matter of fact, they distinguish between these two substances

with the greatest readiness and promptitude. The *Bacillus ethaceticus*, for instance, sets up a vigorous fermentation in a suitable solution of mannite, whilst it refuses to have anything to do with the dulcite under the same circumstances.

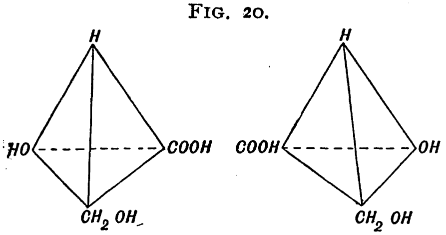
But far more strikingly is this selective capacity displayed on introducing the *Bacillus ethaceticus* into a solution of calcium glycerate, in which it sets up a fairly vigorous fermentation, which comes to an end in about a fortnight. At the close of the fermentation, about one-half of the glycerate is found to have escaped decomposition; but whilst the calcium glycerate, before fermentation, had no action on polarised light, that which remains after fermentation, is found, on examination with the polariscope, to be strongly lævorotary. Now, glyceric acid is one of those substances which chemical theory leads us to believe is composed of an equal number of dextrorotary and lævorotary molecules, combined together so as to form an inactive body—



OPTICAL ISOMERS OF GLYCERIC ACID.

The isomerism of these two glyceric acids is more easily understood by reference to the following geometrical figures, in which the particular atom of carbon, which in the above figures is surrounded with a circle, is represented by a tetrahedron, the four different groups with which it is connected being attached at the solid angles. It will be seen that these four groups can be arranged round the tetrahedron in two distinct ways (as in the figure), so that the two tetrahedra cannot be superposed so as to make the several groups coincide; the two tetrahedra are in fact symmetrical but not superposable. This theoretical conception of the arrangement of the atoms in optically active isomers was originated by Lebel and Van't Hoff in 1874, and has been of immense service in the investigation of the sugars and other bodies in which such isomerism occurs.

FIG. 20.



TETRAHEDRAL MODELS, REPRESENTING OPTICAL ISOMERISM OF GLYCERIC ACID.

The *Bacillus ethaceticus* has the sagacity necessary to distinguish between the molecules of these optical isomers which are combined in the ordinary inactive glycerate, and destroys the dextrorotary molecules by fermentation, whilst it leaves the lævorotary molecules untouched.

This lævorotary calcium glycerate crystallises in beautiful monoclinic prisms, which exhibit hemihedral faces, whist the ordinary inactive salt is not obtainable in a strikingly crystalline form at all.

A number of derivatives of this new active glyceric acid have recently been prepared in my laboratory, and their rotatory power determined :—

DERIVATIVES OF ACTIVE GLYCERIC ACID.

Formula.	Specific Rotation. $[\alpha]$ D
$(C_3H_5O_3)_2$ Ba + $2H_2O$	— 9°
$(C_3H_5O_3)_2$ Sr + $3H_2O$	—10
$(C_3H_5O_3)_2$ Ca + $2H_2O$	—12
$(C_3H_5O_3)_2$ Cd + $1\frac{1}{2}H_2O$	—14
$(C_3H_5O_3)_2$ Zn + H_2O	—22
$(C_3H_5O_3)_2$ Mg + H_2O	—18·5
$C_3H_5O_3$ Na	—16
$C_3H_5O_3$ Am	—20
$C_3H_5O_3$ K	—15
$C_3H_5O_3$ Li	—20·5
$C_3H_5O_3$ Me	— 4·8
$C_3H_5O_3$ Et	— 9·2
$C_3H_5O_3$ Pr(n)	—13·0

All these substances owe their discovery to the idiosyncrasy of my *Bacillus ethaceticus*, which leads it to consume the dextrorotary and to reject the lævorotary calcium glycerate.

FERMENTATION OF INDIGO-BLUE.

In connection with bacterial fermentations, we may glance for a moment at one which has long been industrially employed in a very interesting manner in the art of dyeing.

Amongst the natural dye-stuffs, there is none enjoying a higher reputation, both on account of the fastness and the beauty of the colours obtainable from it, than indigo. There is, however, a peculiar difficulty in the way of applying the material as a dye in consequence of its insolubility in water and other liquids available for dyeing purposes.

But although the indigo-blue itself is insoluble in water, it can easily be converted into a colourless and soluble substance known as indigo-white, by the application of suitable reducing agents. The fibres, &c., to be dyed can then be impregnated with a solution of this indigo-white, and on subsequently exposing them to the air, the indigo-blue is generated on the fibre by oxidation of the indigo-white.

Now this reduction of indigo-blue to indigo-white for the purpose of dyeing was, until recently, invariably effected by a fermentation process carried on in what is known as the indigo-vat.

The suitable medium for this fermentation is secured by mixing the following materials :—

COMPOSITION OF INDIGO FERMENTATION VAT.

Wood Vat.

Indigo	15 kilos.
Woad	300 ,,
Bran	10 ,,
Madder	2—5 ,,
Slaked lime	12 ,,

Tank of water 2 metres wide by 2 metres deep. This is the vat most commonly used in Yorkshire for woollen dyeing.

Potash Vat.

Indigo	10 kilos.
Madder	2—5 ,,
Bran	2—5 ,,
Carbonate of potash	10—15 ,,

Made up with water in similar tank.

The organism which brings about this reduction of the indigo-blue to indigo-white has not yet been either isolated or scientifically investigated; the reduction is, however, generally supposed to be effected through the agency of nascent hydrogen generated in the fermentation, and if this is the case, there should be many micro-organisms capable of bringing about the result, hydrogen being one of the products in a number of fermentations. I am at present engaged in investigating the nature of this fermentative process.

[Experiment.—Demonstration of the indigo-vat dyeing of cotton.]

BACTERIA CONNECTED WITH AGRICULTURE.

By far the most important changes resulting from bacterial life, which have been brought to light through recent scientific research, belong to the domain of agriculture, which we must indeed now regard as the most extensive and chief of the fermentation industries.

The recent investigations in this department have centred round what is undoubtedly one of the most important, and, at the same time, perhaps the most mysterious of the elements, viz., nitrogen, which, though indispensable to all forms of life, is characterised by such apparent inertness in the free state. I say apparent inertness, for we shall presently see that recent discoveries have forced us to greatly modify our views on this particular point. To farmers the question of nitrogen is all important, and we find even the most uneducated rustics with the word nitrogen on their lips.

It is with the nitrogen of the soil that we are more especially concerned this evening.

It is generally admitted, at the present time, that one of the most important plant foods in the soil is nitric acid; and scientific agriculturalists inform us that, if a soil were utterly destitute of this material, it would be incapable of growing the barest pretence of a crop, either of corn, or of roots, or of grass, even if the soil were in other respects of the most superb texture, however favourably situated, however well drained, tilled, and supplied with the mineral ingredients of plant-food, such as potash, lime, and phosphoric acid.

Notwithstanding the commanding importance of this substance, nitric acid, to vegetation, it is present in ordinary fertile soils in but little more than homœopathic doses; indeed it generally requires the most delicate chemical tests to demonstrate its presence at all.

[Demonstration of the presence of nitric acid in 1 lb. of garden soil by means of diphenylamine test.]

Thus in fertile soils there may be under some conditions as little as one part of nitrogen as nitrate, in 1,000,000 parts by weight of soil, and often less than 10 parts, whilst sometimes again the proportion may be as great as 100 parts of nitrogen in the form of nitrate in 1,000,000 parts of soil.

That such minute quantities of nitric acid are present in soil is due mainly to two causes; firstly the very soluble character of the nitrates, which occasions their being easily washed away by the rain; and secondly to the facility with which they are assimilated by plants, and which results in their being rapidly removed by vegetation. If rain and vegetation are excluded, the proportion of nitric acid, it has long been known, can be greatly increased in the soil. The soil, in fact, under ordinary circumstances continuously generates this nitric acid from the various nitrogenous

manures which are applied to it, and it is in the form of nitric acid that the nitrogen of manures principally gains access as nutriment to the plant.

Already Pasteur, in the year 1862, had suspected that this production of nitric acid in the soil was the work of micro-organisms, but it was not until 1877 that this was actually proved to be the case by two French chemists, Schloesing and Müntz. These investigators demonstated that the production of nitric acid, or process of nitrification, as it is commonly called, is at once arrested by all those materials which have the property of destroying micro-organisms, and which we call antiseptics,. whilst, similarly, the process is stopped by heat and all other influences which are known to be fatal to life in general. The vital nature of the nitrification process was confirmed by several others, without, however, coming much nearer the important problem of determining and isolating the particular micro-organism responsible for the change.

Perhaps the most important advance in this direction was made by Dr. Munro, who, in 1886, showed that this process of nitrification could take place in solutions practically destitute of organic matter, which amounted to the statement that the vital activity of the bacteria of nitrification could be maintained without nutriment of an organic nature. Although this discovery was new as regards the bacteria of nitrification, it was not novel as regards some other forms of microbes; for, in 1885, I had already myself shown that some micro-organisms can actually undergo enormous multiplication, even in distilled water:—

Multiplication of Micro-organisms in Distilled Water.

Hours after introduction of Micro-organisms.	Number of Micro-organisms found in 1 c.c. of water.
0	1,073
6	6,028
24	7,262
48	48,100

When I took up the subject of nitrification, in conjunction with my wife, in the autumn of 1886, I determined to make use of this remarkable property possessed by the nitrifying organisms of being able to flourish in the absence of organic matter, thinking that, in this way, it might be possible to achieve a separation of the nitrifying organisms from other forms, which can only grow if organic food materials are supplied to them.

The solution, which we employed for encouraging these nitrifying organisms to the exclusion of other forms, had the following composition:—

Composition of Solution Employed for Nitrification.

Ammonium chloride....	·5 grm.	In 1,000 c.c. of distilled water.
Potassium phosphate ..	·1 "	
Magnesium sulphate....	·02 "	
Calcium chloride	·01 "	
Calcium carbonate......	5·0 "	

In a purely mineral solution of this composition we carried on the nitrification over a period of upwards of four years, as shown in the following Table:—

Experiments on Continuous Nitrification in Mineral Solutions.

Generation.	Date of inoculation.	Quantity taken for inoculation.	Date when nitrification was first observed.
I	9 5 1887	Original garden soil	20 5 1887
II	25 6 "	3 needle loops from I	30 6 "
III	1 7 "	" " II	7 7 "
IV	14 7 "	" " III	23 7 "
V	25 7 "	" " IV	17 8 "
VI	26 8 "	" " V	1 10 "
VII	3 10 "	1 needle loop from VI	7 10 "
VIII	7 10 "	1 needle point from VII	17 10 "
IX	7 10 "	" " VIII	29 10 "
X	7 11 "	" " IX	30 11 "
XI	1 12 "	" " X	15 12 "
XII	16 12 "	" " XI	13 1 1888
XIII	28 1 1888	" " XII	20 2 "
XIV	29 2 "	" " XIII	5 4 "
XV	7 4 "	" " XIV	27 4 "
XVI	30 4 "	" " XV	10 5 "
XVII	12 5 "	" " XVI	26 5 "
XVIII	19 7 "	" " XVII	3 9 "
XIX	3 9 "	" " XVIII	1 10 "
XX	11 10 "	" " XIX	20 11 "
XXI	24 11 "	" " XX	25 2 1889
XXII	26 2 1889	" " XXI	4 5 "
XXIII	28 6 "	" " XXII	18 10 "
XXIV	4 11 "	" " XXIII	17 12 "
XXV	27 12 "	" " XXIV	25 4 1890
XXVI	16 5 1890	" " XXV	2 7 "
XXVII	15 7 "	" " XXVI	30 1 1891
XXVIII	3 3 1891	" " XXVII	28 5 "

But although this continuous cultivation of the soil-organisms in a medium free from organic matter led to the elimination of a number of forms foreign to the nitrification process, it did not lead to a pure culture of the nitrifying organisms, for several other forms also persistently maintained themselves in this mineral solution. Various considerations, however, led us to the conclusion that the nitrifying organisms probably differed from the other forms which were still present along with them in being unable to grow on ordinary gelatin-peptone, for every attempt to isolate a nitrifying organism by gelatin-plate cultivation proved fruitless.

It became necessary, therefore, to fall back on what I described in the second lecture as the "dilution process." For this purpose one of these nitrifying solutions was enormously diluted, and from this diluted liquid small portions were taken out, and each of these fractions was introduced into a separate ammoniacal solution of the same composition as that already indicated. In some of these solutions thus inoculated, nitrification took place, showing that the nitrifying organism had been introduced, in others there was no nitrification showing that the inoculation had not conveyed a nitrifying organism. Further, on examining those solutions which had nitrified, it was found that most of them contained organisms growing on gelatin, whilst one, although it had nitrified, yielded no growth whatsoever on gelatin, whilst under the microscope it was seen to contain an abundance of bacteria having the form shown in the diagram.

FIG. 21.

NITROUS FERMENT (Percy Frankland).

These results of ours were published in March, 1890, and about a month later there appeared in the "Annales de l'Institut Pasteur" a communication by M. Winogradsky, announcing the separation of a very similar, if not identical, nitrifying organism; whilst a few months latter again a separation of a similar organism was made by Mr. Warington.

The method of isolation adopted by Winogradsky was different from ours, although likewise based on the incapacity of this organism to grow on gelatin. Pouring plates of a nitrifying solution, he allowed the colonies to develop; but having found, by previous trial, that none of these belonged to the nitrifying organism, he removed portions of the gelatin film lying between the colonies, thinking that the nitrifying organism must be present there; and on innoculating these portions of the gelatin destitute of colonies into suitable solutions, he actually obtained nitrification. You will remember that, in my second lecture, I referred to this particular method of using gelatin plate cultures for the isolation of organisms which refuse to grow on gelatin.

But these discoveries had not completely explained the phenomenon of nitrification, for the organisms separated in these three independent investigations possessed in each case only the power of converting ammonia into nitrous and not into nitric acid. Nitrous acid is an intermediate body which, curiously, is rarely found, excepting in very minute quantities in soil, nitric acid being comparatively far more plentiful. The changes will be more clearly understood by reference to the chemical equations:—

$$(1)\quad \underset{\text{(Ammonia.)}}{NH_3} + \underset{\text{(Oxygen.)}}{3\,O} = \underset{\text{(Water.)}}{H_2O} + \underset{\text{(Nitrous acid.)}}{HNO_2}$$

$$(2)\quad \underset{\text{(Nitrous acid.)}}{HNO_2} + \underset{\text{(Oxygen.)}}{O} = \underset{\text{(Nitric acid.)}}{HNO_3}$$

The organisms separated by Winogradsky, by Warington, and by myself, possessed only the property of effecting the first of these changes, they were absolutely destitute of the power of bringing about the second.

That this organism is unable to bring about the second of these reactions is particularly remarkable, inasmuch as this is the one which can be most readily accomplished by purely chemical means.

Thus the powerful oxidising agent, potassium permanganate, has no action on ammonia, whilst it readily oxidises nitrous to nitric acid.

[Experiment.—Add potassium permanganate to a solution of ammonium sulphate acidulated with sulphuric acid, the pink colour of the permanganate is not discharged.]

[Experiment.—Add potassium permanganate to a solution of potassium nitrite acidulated with sulphuric acid, the pink colour of the permanganate is at once discharged.]

In fact, in order to bring about the oxidation of the ammonia by chemical means, we have to resort to one of the most powerful of oxidising agents known to chemists, viz., ozone; but this agent, then, produces nitric as well as nitrous acid.

[Experiment.—Show the presence of nitrous and nitric acids in ammonia which has been submitted to the action of a current of ozonised oxygen.]

The power of oxidation possessed by our nitrifying organism is, therefore, altogether unique, doing as it does the arduous work of converting ammonia into nitrous acid, but absolutely refusing to undertake the trivial task of converting nitrous acid into nitric acid.

But how, then, is the nitric acid which is found in the soil produced, seeing that these organisms only yield nitrous acid?

At the time when I found that the organism which I had separated produced nitrous acid exclusively, I pointed out that it was doubtless explicable on one of the two following alternative hypotheses:—(1) The nitrous and nitric acids are produced by totally distinct organisms; or (2) one organism produces nitrous or nitric acid according to the conditions under which it is growing.

More recent researches of Warington and Winogradsky have shown that the first of these two alternative hypotheses is the correct one; for, by making cultivations of soil in a solution containing nitrous acid and no ammonia, a micro-organism has been isolated which is endowed with the capacity of transforming nitrous into nitric acid, but has no power of oxidising ammonia.

FIG. 22.

NITRIC FERMENT (Winogradsky).

This second organism, or nitric ferment, as we may call it, resembles in its activity the purely chemical oxidising agent, potassium permanganate, which, as we have seen, has no action on ammonia, but rapidly converts nitrous into nitric acid.

The process of nitrification in the soil now becomes intelligible in its entirety. It is the work of two independent organisms, the first of which converts ammonia into nitrous acid, whilst the second transforms into nitric acid the nitrous acid produced by the first.

Not only is this process of nitrification going on in all fertile soil, but enormous accumulations of the products of this process, in the shape of nitrate of soda, are found in the rainless districts of Chili and Peru, from where the Chili saltpetre, as it is called, is exported in immense quantities, more especially to fertilise the overtaxed soils of Europe. Thus, during the first six months of 1890 there were brought to the United Kingdom 90,000, and to the European Continent 480,000 tons of nitrate of soda from South America.

FIXATION OF FREE NITROGEN BY PLANTS.

There is yet another agricultural question of tremendous importance, both practically and theoretically, which I must touch upon in my lecture this evening.

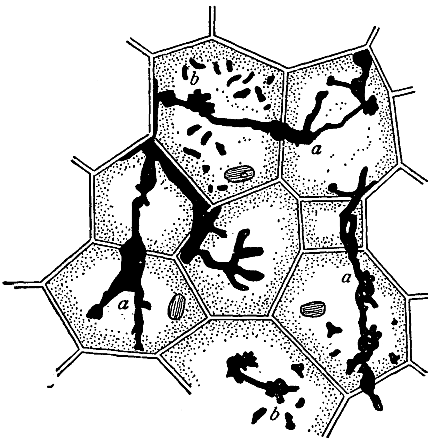
For nearly a century past, agricultural chemists and vegetable physiologists have been debating as to whether the free nitrogen of our atmosphere can be assimilated by plants. This question was answered in the negative by Boussingault about 50 years since. The problem was again attacked by Lawes, Gilbert, and Pugh, about thirty years ago, and their answer was in the negative also. In the course, however, of their continuous experiments on crops, Lawes and Gilbert have frequently pointed out that whilst the nitrogen in most crops can be accounted for by the combined nitrogen supplied to the land in the form of manures and in rain-water, yet in particular leguminous crops, such as peas, beans, vetches, and the like, there is an excess of nitrogen found in the crop which cannot be referred to these obvious sources. It has, indeed, been known for 2,000 years that the fertility of the soil can be improved by the growth of leguminous crops.

The question remained in this unsatisfactory state until again revived by M. Berthelot in 1876, whilst subsequently the most conclusive experiments were made by two German investigators, Hellriegel and Wilfarth, who not only showed that this excess of nitrogen in leguminous crops is obtained from the atmosphere, but, what is more interesting to us, that this assimilation of free nitrogen is effected by means of certain micro-organisms flourishing in and around the roots of these plants, for when these same plants are grown in sterile soil the fixation of free atmospheric nitrogen does not take place.

The manner in which these micro-organisms assist these leguminous plants in the accumulation of nitrogen is exceedingly remarkable. When these micro-organisms are present in the soil, they occasion the formation of peculiar swellings or tuberosities on the roots of the leguminous plants, these tuberosities being never formed in sterile soil.

On microscopic examination these tubercles

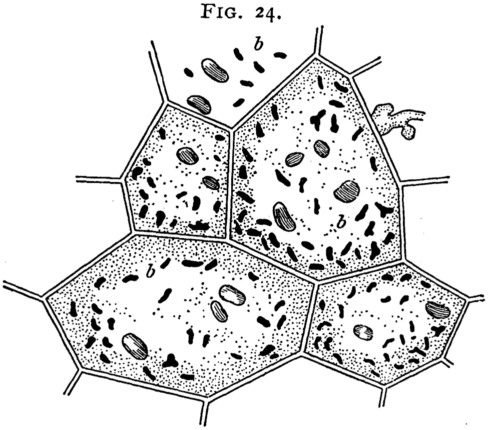
FIG. 23.



SECTION THROUGH TUBERCLE OF LEGUMINOUS PLANT. (After Laurent.)

(*a*) Ramifying growths extending through the polygonal plant cells; (*b*) bacteroids present in small numbers only.

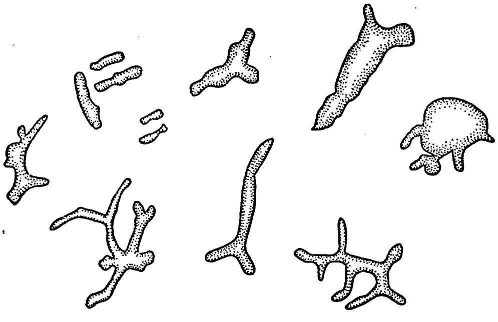
FIG. 24.



SECTION THROUGH TUBERCLE OF LEGUMINOUS PLANT, AT A LATER STAGE OF DEVELOPMENT. (After Laurent.)

(*b*) Bacteroids present in considerable numbers in each of the polygonal plant ce'ls. The ramifying growth has disappeared.

FIG. 25.

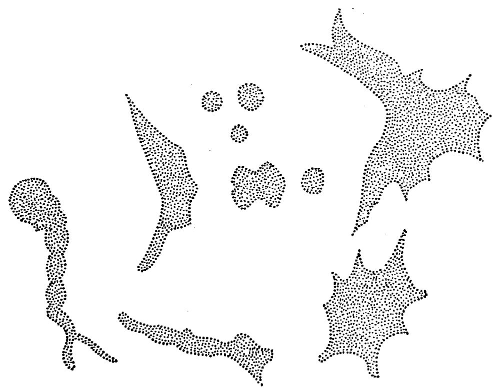


INDIVIDUAL BACTEROIDS, HIGHLY MAGNIFIED. (After Laurent.)

are found to contain amongst their cells a ramifying growth which subsequently gives rise to a number of small cells having much the appearance of bacteria, although the precise group of organisms to which they belong is one of those numerous points on which morphologists cannot agree. As long as this point is still *sub-judice* it is perhaps most convenient to call these small bodies *bacteroids*. In the foregoing figures, which are prepared frcm the beautiful drawings of M. Laurent, the appearance of these ramifying growths and of the bacteroids to which they give rise are represented.

These bacteroids can be cultivated on artificial media like ordinary bacteria, and the next slide shows the appearance of some of the colonies to which they give rise on gelatin plate culture.

FIG. 26.



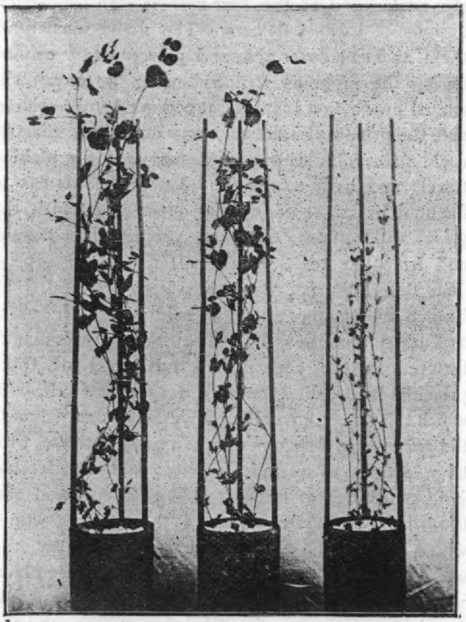
BACTEROID-COLONIES ON GELATIN-PLATE. (After Laurent.)

The careful investigation of these tubercle-producing organisms has shown that each species of leguminous plant has its particular bacteroid which is more potent in the formation of these tubercles on the given species than the tubercle bacteroids of other leguminous species. In this connection, some very striking and highly instructive experiments have been made by Prof. Nobbe, of Tharand.

This investigator has found that if pure cultivations of the bacteroids from a pea-tubercle are inoculated into the roots of a pea-plant, a more abundant growth and fixation of nitrogen by this pea-plant takes place than if it is inoculated with pure cultures of the bacteroids from the tubercles of a lupin or a robinia; whilst, conversely, the robinia is more beneficially affected by the application of pure cultures from robinia-tubercles than by those from either pea-tubercles or lupin-tubercles.

The exact manner in which the atmospheric nitrogen is rendered available for these leguminous plants possessing root-tubercles is not perfectly understood, but the general impression is that the micro-organisms present in the tubercles take up the nitrogen and elaborate it into a form which can be assimilated by the plant. Whatever the secret of the process may be, it is perfectly certain that the presence and vital activity of the micro-organisms which give rise to the root-tubercles is the indispensable factor.

FIG. 27.



No. 1. No. 2. No. 3.

PEA-PLANTS. (After Nobbe.)

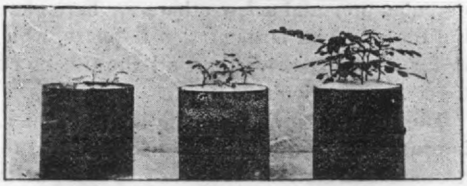
No. 1. Inoculated with pure cultures from tubercles of pea. No. 2. Inoculated with pure cultures from tubercles of lupin. No. 3. Inoculated with pure cultures from tubercles of robinia.

The inoculations were all made on Aug. 14, 1890, and the plants photographed on Oct. 9, 1890.

The great importance of this discovery in vegetable physiology it is unnecessary for me to dwell upon, we have to recognise in these micro-organisms the invaluable agents whereby the atmospheric nitrogen, which is in itself worthless, both to animals and ordinary plants, is actually rendered available directly for the nutrition of plants, and therefore indirectly for the sustenance of animal life on our planet.

I regret that the time has now come for me to bring to a close my discourse on the subject of these microscopic creatures which surround us, and which are in so many cases performing works of inestimable value. I must, in the first place, offer you my sincerest thanks for the kindness and patience with which you

FIG. 28.



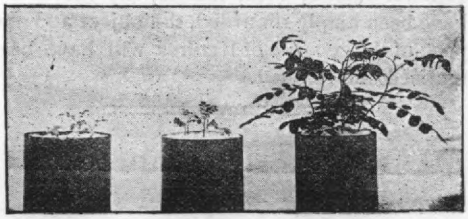
No. 1. No. 2. No. 3.

ROBINIA. (After Nobbe)

No. 1. Uninoculated. No. 2. Inoculated with pure cultures from pea-tubercles. No. 3. Inoculated with pure cultures from robinia-tubercles.

The inoculations were made on June 27, 1890; the plants were photographed on Aug. 5, 1890.

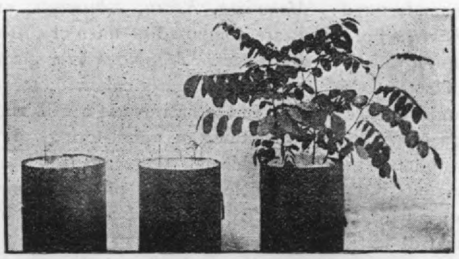
FIG. 29.



No. 1. No. 2. No. 3.

Photographed on Aug. 21, 1890.

FIG. 30.



No 1. No. 2. No. 3.

Photographed on Oct. 3, 1890.

have listened to much which was doubtless not new to many. It has been my endeavour to present to you in outline the principal points which are at present exercising the minds of those who are devoting their lives and energies to the study of fermentation phenomena, using

that term in its widest significance. From what I have said, you will see that the width of that significance is daily becoming greater and is all but coextensive with life itself. As I have pointed out, the fermentation-industries must no longer be supposed only to include brewing, distilling, wine-production, vinegar manufacture, and a few others as heretofore, but the principal fermentation-industry, which is far more extensive than all the others put together, is agriculture itself.

The study of these fermentation phenomena is progressing with such rapid strides, and the accumulated material is already so overwhelming, that I have of necessity had to omit much that might have well found a place had time only permitted. If, however, in marshalling before you, as I have done, the recent discoveries in this branch of science, I shall have succeeded in arousing in any one here present such interest as will lead to his entering the ranks of the cultivators of this fertile domain of science in which so much still awaits the explorer's hand, then, indeed, my efforts will have been amply rewarded, the object and purpose of this course of lectures will have been realised and fulfilled.

Miscellaneous.

THE TEXTILE INDUSTRIES OF TREBIZOND.

In the textile industries of Trebizond, which, according to the French Consul there, are not in a very flourishing condition, the following articles are manufactured:—*Manoussa*, *Kétau*, *tchumbels*, and *havli*, all of which are composed of linen or cotton, and a variety of silk tissues. *Manoussa* is a species of cotton cloth, striped and party-coloured, strong and well dyed, of which the natives use considerable quantities, either for clothing or upholstering. It is estimated that, at Trebizond, there are 600 looms manufacturing this article, a piece of which, measuring from 6 to 8 metres long and about 50 centimetres wide, is valued at from 7 to 13 piastres. On an average, 40,000 pieces of the cloth are sold annually, either for local consumption or for the towns on the coast and the neighbouring villages, and the yarns used in its manufacture come from England and Germany. *Kétau* is a tissue of hempen yarn manufactured principally at Kizeh and its environs, and generally known as Trebizond cloth. The annual production is about 150,000 pieces, and each piece is 27 metres long and about 50 centimetres wide, being valued at from 14 to 250 piastres, according to the degree of its fineness. This cloth, although somewhat resembling muslin, offers considerably more resistance, and is used in making shirts and drawers. Large quantities are exported to warm climates, such as Bagdad, Bassorah, Yemen, and Hedfaz. It is in the environs of Kizeh and in the plain of Tcharchamba, that the raw material—that is, the hemp—used in the manufacture of this cloth is found. On leaving the loom it is perfectly black, and is bleached by sea water. The finer descriptions of cloth are ornamented at one of the extremities by designs in fine gold, and the common qualities by designs in imitation gold. By *tchumbels* is understood a sort of muslin handkerchief, manufactured with pieces of stuff imported from England, these being dyed at Trebizond, and ornamented in the centre and at the four corners with hand-made designs of various flowers. The native women use them as head coverings, and preserve this coiffure during the night as well as during the day. The annual production is valued at 200,000 handkerchiefs, and the price varies between one and three piastres each. *Havli* is a cotton tissue used for making towels and bath wrappers. This article is manufactured in larger or smaller pieces, of which the price varies from 6 to 10 piastres for towels, and from 20 to 25 piastres for bath wrappers. This description of tissue has been imitatated by French manufacturers, and is sold in French houses as Turkish serviettes, &c. The tissues of silk manufactured in the country are composed of three principal kinds, the *tcharchaf*, a species of veil, with which the women cover themselves when out of doors; the *puchtemas*, a species of apron of light tissue, with large stripes of various colours; and, finally, the *kéfié*, or girdles of striped stuff, parti-coloured and fringed. The *tcharchaf* are of three kinds, white, with a broad band of violet; striped, with grey on a white ground, in the form of checks; and quite plain, and dyed in red, violet, or black. The two first descriptions are worn by Christian women, and the third by Mussulman women. The white *tcharchafs* are held in the highest esteem, and fetch prices varying from 300 to 350 piastres each; those with checks, from 200 to 250 piastres; and the plain description or those dyed in red, violet, or black, realise from 220 to 240 piastres. The *puchtemas*, as well as the *kéfié*, are sold at the rate of 40 to 50 piastres each. The raw silk which is used in making up these stuffs comes from Amassia, Bafra, and Tcharchamba. The average production of Amassia raw silk is estimated at 10,000 ocques annually (ocque = 2·8 lbs. avoirdupois), and its price is from 46 to 54 francs the ocque. It is estimated that from 12 to 15 ocques of cocoons yield one ocque of silk. The Tcharchamba and Bafra yield of raw silk is from 300 to 400 ocques annually, and the whole of this quantity is used at Trebizond.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

REPORT ON THE PROGRESS OF WORK.

By Colonel Hayes Sadler.

[*Continued from p.* 947.]

ALLOTMENTS AND EXHIBITS.

No detailed statement of the allotments which have been made can be given, but applications have been received for more than five times the amount of space at the disposal of the Directors, who are engaged in making arrangements to provide room for only the most desirable exhibits. The allotments to foreign Governments have all been completed, except those to Italy, Switzerland, and the Netherlands, which countries have recently appointed official Commissions, and endeavours are being made to satisfy their demands. All the space has been allotted in the Manufactures and Liberal Arts Building, and, no further space being available, the Direction have recently given to Spain a small portion reserved for United States exhibits, with a view to accommodate that country, to which no space had been allotted. Among the allotments in the Fine Arts Building, 24,324 square feet hanging space have been reserved for America, 21,325 square feet allotted to England, 2,895 square feet to Canada, 29,201 square feet to France, and 20,340 square feet to Germany. A special piece of ground has been granted to the Krupp Gun Company, for the erection, at their expense, of a building to contain the 120-ton gun—the largest ever built—and other ordnance.

The enormous demand for space—so many times greater than these gigantic buildings can accommodate—demonstrates the enthusiasm reported to exist, not only in America, but in almost every foreign country, with regard to the Exhibition; and preparations on a large scale seem everywhere to be progressing, so that each country may be as well or better represented than on any former occasion.

To enumerate the nature and variety of foreign exhibits promised would be impossible, but there are indications, in many instances, of a desire to outstrip former efforts, as well as other countries, in the character and completeness of display; and it has been found impossible to meet additional demands for space which have been made since the importance of the Exhibition has been recognised. There are some foreign countries, especially the Central and South American Republics, which have never been represented in the manner they will be at the Chicago Exhibition.

Foreign exhibitors are permitted to fix upon placards attached to their exhibits the price at which these will be sold at the place of manufacture, or in and out of bond, exclusive or inclusive of the Customs duties of the United States. All exhibits will be admitted free of duty, but must pay duty if they are sold or remain in the country. Such articles also as may be imported solely for exhibition which may be consumed or destroyed in their application to the process they are intended to illustrate, will be admitted free, and satisfactory evidence of such consumption or destruction will be accepted at the close of the Exhibition as authority for closing the Customs accounts of the respective articles. No citizen of any other country will be held liable for the infringement of any patent granted by the United States, or of any trade mark or label registered in the United States, where the act complained of shall be performed in connection with the exhibit of any article or thing at the World's Columbian Exposition.

The Collector of Customs has already taken possession of the bonded warehouses, which are finished, and such exhibits as have come to hand are now deposited there, while all fresh arrivals will be delivered on the grounds. The terminal charges on exhibits sent to the World's Fair are reduced from 4d. to 3d. per 100 lbs., which must be paid both ways.

With regard to American exhibits and inventions there will be a great deal to see. This continent has been but imperfectly represented at European exhibitions, and yet nowhere have greater advances been made in all branches of manufacture and trade, in labour-saving machinery and appliances, in science and invention. The show of machinery, minerals, manufactures, transportation, and agricultural produce promises to be very extensive and

complete. Exhibits from some of the States have already arrived, and selection has been found necessary, from want of space, to meet all demands. In the Transportation Building will be concentrated every description of means of locomotion by land or water, locomotives, fully equipped trains, marine appliances, equipments, naval armaments, and models of ships from leading builders and companies, besides models of lighthouses, bridge and harbour works, lifeboats, steam and electric launches, bicycles, &c. The Forestry Building is surrounded by a colonnade composed of timber from all the States of the Union. The pillars are in groups of three, the centre one, of 20 inches diameter, flanked on each side by a column of 12 inches in diameter, and all the hard woods of the country are represented. The Women's Building promises an interest peculiar to this Exhibition, and will contain all the finest efforts of the industry and talent of the sex. The line of separation, however, to be drawn between the women's works to be exhibited in this building and those to be exhibited with men's work in the different exhibition buildings, appears less clear. The project of providing a Children's Home associated with this building, for the purpose of relieving tired mothers, is fairly launched, and a building will be erected by subscription, to be furnished with play-rooms, children's books, and scientific toys, under the superintendence of kindergarten teachers. A Women's Dormitory Association has also been formed, with a view to provide women who visit the Fair with proper accommodation at reasonable rates. The Horticultural Show promises to be not only bewildering in extent, but the most complete ever made or attempted, and will form an important feature of the Exhibition in a scientific point of view, as well as in the adornment of the grounds. The building, which is finished, and has been in use for some months, is 998 feet long by 250 feet wide, and the display will include fruit and all that pertains to horticulture. In the southern portion will be the viticultural exhibits, in the rear curtains the exhibits of fruit from all parts of the world, and where it is not possible to show the natural fruit, even with the means of refrigerators and cold storage, perfect wax models will be displayed. The floricultural exhibits will be distributed, and, so as to allow for recovery from the check of transplanting, 50,000 plants and shrubs are already growing in the grounds. In the front curtains will be hothouse and greenhouse plants, and among these a magnificent show of orchids, of which, it is said, there will be 2,000 different varieties. There will be every description of tropical vegetation, with orange groves and other trees in full bearing, and the plan of growing trees by electric light and with the aid of electric currents will be exemplified. There will also be collections of insects, beneficial or injurious to the fruits of horticulture. In long lines of greenhouses to the rear of the building plants will be brought to perfection or stowed away. Six acres in front of the main building, besides spaces round many other constructions, will be devoted to floricultural exhibits; the wooded island, which covers 15 acres, is being laid out with beds of shrubs and flowers, divided by winding walks; at the north end of the island will be a Japanese temple surrounded by choice plants from that country. The amount of space asked for here by the States, particularly California, and by foreign countries, has been far beyond the power of allotment, and some displays will be extended to the Midway Plaisance.

As the enterprise develops, the more convincing it appears that the Chicago Exhibition of 1893 will be by far the most extensive and important which has yet taken place. The effect on the avenues of trade will probably be wide and far spreading. Considerable changes and diversions may result, new connections will be made, and old ones lost. Commerce does not stand still nowadays, nor is trade in these times of great competition won or retained without continued exertion; and however greatly this Exhibition may benefit manufacturing and commercial enterprises in the United States, it undeniably offers the best possible opportunity for advertising, by means of exhibits, to the manufacturers of other countries. The yield out West is large, and there European goods are not widely seen or known, and, at all events, only obtainable at the prices fixed by the American importer, and the liberty, therefore, conceded of affixing on exhibits their cost in and out of bond will be of great advantage in attracting customers; the fear that methods may be copied seems scarcely to warrant abstention or weigh against the advantage of such advertisement, for there are few inventions unknown here or otherwise unobtainable. Rapid changes are taking place in this country, and manufacture is constantly tending to migrate where circumstances are the most favourable and material nearest at hand; formerly the East supplied

the West; the East is now greatly furnished with manufactures of wood and iron, furniture and other trade goods from the factories of Chicago and district; agencies in the East now exist for the shipment and export of many goods manufactured in the West, where but a very few years ago the agency was in the West for the Eastern manufacturing firm. This is a migratory age; communications and transit become yearly more rapid, economic changes more frequent, and the influence of advertisement more extended.

The Exhibition will probably be visited less, proportionately, by pleasure seekers than were former exhibitions, and more by persons interested in the various exhibits. Foreign visitors will be almost entirely those who come with the special view of profiting by and interesting themselves in the goods exhibited, while as regards the United States there are practically no pleasure seekers here, all men being workers and personally and actively engaged in the different businesses of life. Of these vast numbers will come from all parts of the country, bent on taking advantage of every new channel of trade, eager to obtain the best return for capital, and in search of the most perfect methods of diminishing the cost of product and encouraging labour. The whole nation is occupied in business, and the result has been the accumulation of immense wealth, which is less hampered by consequent expenses here than elsewhere. This available wealth is yearly increasing, and so is the disposition to purchase articles of value, the artistic productions and finer works of older countries, and collections or specimens of historic pre-eminence. A love of the beautiful and an appreciation of art is fast growing up, and while the keen business of amassing riches is never lost sight of, the desire to fill their public institutions and private residences with works of art and the product of genius shows a marked advance. Thus, to the foreign exhibitor greater advantage is probably offered by exhibiting at Chicago, where enterprise and wealth have made such strides, and which city is not only the rising business centre, as it is now the centre of the population, of the United States, than could perhaps be offered an exhibition in any other locality.

Other Works and Arrangements.

Besides the principal constructions mentioned above, there are many other buildings and works within the park which will, it is said, be all completed by the time fixed for the dedication. A water station is established for supplying the grounds and buildings and for fire purposes, and the most approved drainage system has been established; about nine-tenths of the water and drainage pipes are laid. An electric lighting establishment has been completed, and about two-thirds of the work done for the incandescent lights. The contract for the installation of 92,000 lamps was taken at £79,800, and arc lights have been contracted for at £21,000, the subways, rubber-covering, and power costing an additional £14,575. The Music Hall, Casino, and Peristyle, which will cost £57,311, are well in hand, and the big pier contracted for will be finished by October 15. The columns and trusses of the Casino are in place, and the columns of the Peristyle as far as the opening connecting the outer harbour and the basin. The foundation piles for the statue of America, to be placed in the lagoon opposite the Administration Building, are driven, and the framework for the big statue of the Republic has been started. All the grading and planting in the grounds have been finished, and a large force of men is engaged in laying the walks and building the roads, which are not yet finished. Dredging the lagoons and harbour, at a cost of £21,900, is nearly finished. The statue of Columbus is well in hand, at a cost of £8,000, and the grand fountain, contracted for at a price of £11,200, will be immediately commenced. The permanent bridges and the railing of the waterways are complete, and all other works are well in hand.

The movable platform has been condemned, and an intramural elevated railway, with stations every 1,000 yards, will be constructed for the purpose of conveying visitors from one part to another of the extensive grounds covered by the various buildings. The cars will be moved by electric traction on the trolley system, with the wires between the rails. It is said the capacity will be 20,000 persons per hour; and passengers will be able to alight at any part of the grounds. Steam and electric launches have been tested, which will ply on the waters of the park between different landing places; express boats will take visitors round the waters, and omnibus, or cab-boats, can be engaged to go from one part to another.

An appropriation of £35,000 has been made for an orchestra of 120 performers during the time the Exhibition is open. Arrangements are being made for a variety of other choral, orchestral, and international musical enter-

tainments; and there will be a Recital Hall, Music Hall, and Festival Hall for 2,000 singers and an audience of 7,000. There will be postal, telegraphic, telephonic, express, and other facilities on the spot. Physicians will be attached to the medical bureau of the Exhibition, where persons falling sick or requiring medicines will be attended, but no drug stores will be allowed. About 150 restaurants will be situated in the principal buildings and in the grounds; in the Manufactures and Liberal Arts Building there will be 16 large *cafés* and 72 private dining rooms, lunch counters in the Transportation Building, and fish lunches in the Fisheries Building. Liquor will be allowed to be sold, but no bars or saloons will be permitted.

The World's Auxiliary Congress, promises to form a very important feature of the Exhibition, and foreign governments have been invited to participate and render co-operation. The work has been organised in 16 departments, and more than 100 general divisions, in which congresses will be held. The most undoubted authorities on every branch of science and art, and representatives of leading institutions from all parts of the world, have been invited, and are expected to attend.

With the 13 immense principal constructions, at least 100 special Exhibition structures, and other works, Jackson-park will have the appearance of a city in itself. Outside the park, along the Midway Plaisance, will be grouped a number of other structures, for which concessions are required.

[*To be continued.*]

Proceedings of the Society.

CANTOR LECTURES.

USES OF PETROLEUM IN PRIME MOVERS.

By Professor W. Robinson, M.E.,
Assoc. M.Inst. C.E., University College, Nottingham.

Lecture I.—Delivered February 29, 1892.

Introductory.

The use of petroleum and its products in various forms, for heating and motive power purposes, has received much attention during the last few years. Especially recent important advances have been made in the application of oil as fuel, instead of coal gas, in the cylinder of the internal combustion engine since last year, when I had the honour to bring the subject before this Society. But with this extended use of mineral oil, both as fuel and lubricant, experience goes to show that the general public, and even some practical engineers, have rather vague notions, and exhibit wonderful ignorance, as to the character and properties of petroleum.

What is meant by Petroleum?

Perhaps such ignorance is in part due to the fact that the one word *petroleum* is often used to describe very different substances, which are, in themselves, of complex composition and constitution. Thus in the widest sense of the term, *petroleum*, or *rock-oil*, comprises not only the different mineral oils which flow from the earth's crust, but also the solid as well as partly gaseous hydro-carbon products obtained by the distillation of bituminous shales, Boghead coal, and peat. There are then, at least, two distinct classes of mineral burning oils. The one extracted from bituminous shale is sometimes called "paraffin oil," and the other, known as "refined petroleum," is the product of crude petroleum found in the earth in the liquid state.

Different Sources of Supply.

Immense stores of natural crude petroleum exist in America, and in Russia especially about the Caspian Sea, and the supply from these sources appears to be unlimited. Oil is to be met with in other countries, as Peru, India, Burmah, Galicia, and probably in England.

Bituminous shales are also found in great abundance in many parts of the earth's crust. In Great Britain the manufacture of the various commercial products from shale has grown up into an important chemical industry. In 1850, Dr. James Young pointed out the way to produce paraffin oil by distillation from shale. Shortly afterwards the Americans started coal-oil refineries, and the American refiners imported Boghead mineral from Scotland, and were even using their own bituminous and cannel coals to make oil in the year 1859, when the great discovery was made that any quantity of crude petroleum oil was to be had by simply sinking wells for it, and since then the petroleum industry has grown rapidly.

Kinds of Oil Available.

Crude shale-oil, got by the destructive distillation of bituminous shale in closed retorts, is a dark green, strongly smelling, viscous fluid

of specific gravity ·865 to ·870, and resembles crude natural petroleum obtained direct from oil-wells in the earth.

I have here on the table some bituminous shale itself, and you will observe that the samples of crude oils from the oil wells in the United States, and that from the wells at Baku in Russia, although varying slightly in colour and appearance, are much like the heavy shale oil.

Now these three crude oils—the product of bituminous shale, and crude petroleum oils from America and Russia—are subjected to somewhat similar processes of treatment, being first split up by *fractional distillation* into several hydro-carbon products, which are separated and then refined by slightly different processes of *chemical purification*, yielding the various finished commercial products, and known as refined petroleum.

This part of our subject was fully dealt with in a course of Cantor Lectures on "Petroleum and its Products," delivered in this room by Mr. Boverton Redwood, in 1886, after he had visited the principal oil-fields and studied the subject thoroughly; and, through his kind ness, I have a few samples of the chief petroleum products here on the table before you to-night.

Supply of Petroleum.

The production of these oils is steadily increasing, and new oil-fields are being developed. In 1889, the total production of crude petroleum in the United States was 35,000,000 barrels (each of 42 American gallons); and, during the year 1890, the shipments of crude petroleum from the oil regions of Pennsylvania and New York alone amounted to 30,628,739 barrels (of 42 American gallons). In these fields 6,358 new wells were completed during the year 1890, the number for 1889 having been 5,489. The average daily production was thus increased from 61,306, in 1889, to 78,588 barrels in 1890.* In Russia, the Baku oil-fields produced 68,000 barrels (of 42 gallons) per day during 1889, and this was increased to 80,000 barrels per day in 1890. In 1890, the shipments of petroleum oil from the United States and Russia to the United Kingdom was 2,144,651 barrels, of which 1,357,122 barrels were American.

Properties of Oils.

Crude petroleum consists of a mixture of hydrocarbons which have very different boiling points. The lighter constituents are very volatile, some of them evaporating rapidly when the mixture is exposed to the air. Thus, a little petroleum spirit poured on the hand or table evaporates, and should leave no odour. If heated in a crucible over boiling water, a good sample of petroleum spirit evaporates rapidly, and leaves no black oily residue of heavy hydrocarbons behind. The light oils, or highly volatile hydrocarbons, as gasoline, petroleum spirit, and benzoline, are dangerous, because they readily exist in the gaseous state, and are exceedingly inflammable.

Products of Distillation.

When the heavy crude oil is heated in a still, the constituents, having different boiling points, are distilled off as the temperature is gradually raised. The weight and boiling points of the products of distillation are found to increase gradually in much the same proportion. After the light oils we get separated off the "burning oils" of commerce, known as "kerosene." In the next distillation, in which superheated steam is used, the product is the oil used for lubricating machinery; but between the "burning oils" and "lubricating oils" we have the so-called "intermediate" oils. The heavier products obtained after this are "solid paraffin wax" from shale, and "vaseline" from petroleum. Then there is a residue left in the form of a heavy liquid, which is used as fuel, known as "residuum" in America, and "astatki" in Russia.

The crude American petroleum consists chiefly of a mixture of hydro-carbons, known to chemists as paraffins ($C_n H_{2n+2}$), of which marsh gas (CH_4) is the first member. These paraffins, when heated above their normal boiling points, are split up, and become changed or decomposed into olefines ($C_n H_{2n}$) as $C_2 H_4$, at the same time gas is evolved and carbon deposited.

Cracking Process.

We find, then, from the heating of paraffins or petroleum above their normal boiling points, as will occur when some distillate is condensed in the still, and falls back into the hot liquid, which is at a higher temperature than the boiling point of the condensed distillate, the latter becomes decomposed, and the resulting products mainly consist of a mixture of various paraffins and olefines. Heavy condensed oils of specific gravity ·880 may thus be split up or decomposed, by properly regulating the heat,

* See "The Year-Book of Commerce" for 1892, and the "Statesman's Year-Book." The former gives a review of the petroleum industry.

into lighter oils of gravity ·820. This process of breaking up heavy oils into lighter burning oils is called "cracking," and is one of the means by which Americans obtain a much larger yield of burning oils than the petroleum would produce by ordinary fractional distillation. One peculiarity of burning oils manufactured from American petroleum by the "cracking" process is, that they contain a large proportion of olefines depending upon the particular method and conditions of preparation; whereas, the paraffins are characteristic of crude American petroleum.

The lubricating oils are mainly made up of olefines, and are purified by filtration through animal charcoal.

Tests of Petroleum.

You will observe that these different refined petroleum oils vary in colour from clear or colourless burning oils—"water-white"—to pale yellow, straw colour, amber, and dark brown lubricating oils.

We distinguish these oils in a rough and ready way by their colour, peculiar blue fluorescence, and smell; but the properties of oils are better ascertained by putting test questions in the form of experiments, though it must be borne in mind that in the interpretation of the replies, strict accuracy and careful attention to details are of the greatest importance.

Specific Gravity.

Now, the first question which arises is—What is the weight of the oil?

The specific gravity of an oil is the ratio of its weight to that of the same bulk of distilled water at the temperature of 60° Fahr. The standard substance, water, is taken as 1 or 1,000. The specific gravity of oil is usually determined by means of an ordinary direct reading hydrometer. A suitable hydrometer, such as the instrument in my hand, is immersed in the oil, and if it floats freely, you read off the scale number at the surface of the oil that corresponds to the specific gravity. It is important that the temperature of the instrument should be the same as that of the oil, and both the oil and instrument should have remained in a bath for some time, to have reached the standard temperature of 60° Fahr. or 15·5° C., in order that the reading may be of use for reference with other oils under the same conditions. There must, therefore, be a standard temperature for reference; and sometimes the oil takes a considerable interval of time to arrive at the exact temperature of the bath. You see that the weight of the floating instrument is equal to the weight of the liquid oil displaced by it. Here the weight of the float remains always the same, and it is simply equal to the weight of the liquid displaced; therefore, this instrument will sink further into light warm oil than in cold heavy oil, so that the bulk immersed varies inversely with the gravity of the liquid. The temperature should be carefully noted in all cases.

Use of Derham's Hydrometer.

Accurate determinations may be made by means of another instrument I have here, known as "Derham's hydrometer." It is an improved form of the Sikes hydrometer, and enables you to determine the specific gravity of liquids from ·780 to 1·000 directly from the scale reading, without reference to tables, by the use of poises, which consist of little platinum weights fixed in pieces of ebonite, the weight and bulk of each poise being correctly adjusted beforehand to the middle value of the range of specific gravities it is intended to measure. Below the usual gilt ball there is the little stirrup, into which are fixed these poises of different sizes. It is necessary that the law connecting together the bulk of the instrument immersed, and the specific gravity of the oil should be exactly fulfilled. The scale reading goes from 0, at the top, to 20 at the bulb. Starting without any poise at all, when the instrument floats to the zero mark on scale, the specific gravity of the liquid is ·780. When another heavier liquid is tried, it buoys up the instrument more, and, consequently, the scale reading increases until you reach 20, and this, added to 780, gives the specific gravity 800 or ·800. For heavier liquids the poise marked 800, is placed in the stirrup, and the scale reading added to this number gives the gravity. In this way, by selecting the proper one out of a graduated series of poises, the weights and bulk of which have been accurately adjusted, the specific gravity of different kinds of oil may be quickly and accurately ascertained, and the one instrument takes the place of a whole series of hydrometers.

Mohr's Balance.

Mohr's specific gravity balance enables us to determine rapidly with accuracy the specific gravity of gases and liquids within a very wide range. The simplest form of this little instru-

ment is on the table, and I wish to show you how to work with it. It is simply a balance. The float hangs from the arm of the balance by a thin piece of platinum wire. The float is balanced first of all in air, and when immersed in the oil it is buoyed up, and loses weight equal to that of the oil displaced. Then put one of a graduated series of little weights or riders along the graduated arm until balance is restored. The marked positions of the riders give the specific gravity. Thus the heaviest rider represents gravities from ·1 up to ·9, depending on its position along the arm to give balance. This heaviest weight, being at the extreme end, would make the balance true, if the float were immersed in distilled water at the standard temperature, that is the standard specific gravity 1 or 1,000. Smaller riders are used in the same way for the second and third place of decimals. This float also acts as a simple thermometer. Instead of it plummets of glass may be used for very heavy liquids. The float may be kept constantly in the liquid, and the temperature carefully noted when there is balance. This is a simple and very accurate method of observing the specific gravity of the oil at different temperatures.

Besides, the *specific gravity bottle* may be used to find the gravity of oils in the laboratory, where a delicate balance of great sensibility is available.

Expansion due to Increase in Temperature.

You will have noted that, in order to ascertain the specific gravity accurately, it is always necessary to observe the temperature of the oil, so that the temperature correction may be made to reduce the weight of unit volume to what it would be under standard conditions. Oils change very considerably in volume with change of temperature. I have measured the expansion of several samples of ordinary burning oils by the *weight thermometer*, and checked the results by comparing the specific gravities by Derham's hydrometer at 15·5° and 40° C., the average co-efficient of expansion for this range of temperature is about ·00084 per degree Centigrade for American Royal Daylight oil of specific gravity ·811, and ·00085 for Russian ordinary burning oil (Russoline) of specific gravity ·824, whilst Russian "Lustre" oil of gravity ·825, and the Broxburn Lighthouse oil of gravity ·810 have the same co-efficient of expansion ·00089 per 1° C. It clearly follows, since these oils increase so rapidly in volume with increase of temperature from winter to summer in this country, that temperature corrections must be made in finding their specific gravity. We have, then, the simple rule, *to find the correct specific gravity we must add to or substract from the observed specific gravity* ·0007 *for every* 1° *C. above or below the standard temperature* 15·5° *C., or* ·0004 *for every* 1° *Fahr. above or below* 60° *Fahr.* This seems to be a fair average of the corrections I have found for several ordinary kerosene oils I have examined, as shown in Table I. (p. 964). In making these determinations, perhaps the simplest plan is to observe the specific gravity of the oil first at the standard temperature, and again at a very much higher temperature, then note the difference in the specific gravity for the given range of temperature, and hence deduce the average change per degree.

Danger of Petroleum Spirit.

Many people do not seem to know the difference or distinguish between ordinary burning petroleum oils called kerosene, which are safe, and a light dangerous petroleum oil such as benzoline, the storage of which in large quantities in town is prohibited by law.

Perhaps the following simple experiment may prove useful on this point to illustrate the danger of the lighter oils, and show you the comparative safety of the burning lamp oils. Here are a number of small tin vessels on a tray, and into each of these I pour a sample of common burning oils—Lighthouse oil, American Royal Daylight, ordinary Russian oil (Russoline). These oils are exposed freely to the atmosphere, and if I apply a lighted taper to the oils, it not only fails to ignite them, but is at once extinguished when immersed in the oils. You see that these oils do not burn, and are not so very dangerous as is sometimes imagined. A lighted match dropped into any of these oils is also extinguished, and even the burning taper with large flame is put out when held in the most volatile of them. Indeed, the electric arc may be made to pass between two carbon rods immersed in the oils without igniting them, but the oils soon become charred by the passage of the spark. A small piece of red-hot iron is made quite cool when thrown into a considerable quantity of any of these oils, although the frequent repetition of this experiment on a sample of oil is not attended with agreeable odours.

TABLE I.—TYPICAL SAMPLES OF PETROLEUM OIL.

Name of Oil.	Colour.	Wholesale price naked, delivered in London & Liverpool.	Specific gravity at 15·5° C. (60° F.)	Specific gravity. Corrections per 1° C.	Coefficient of expansion, per 1° C.	Specific Heat.	Flashing Point by Abel close test.		Boiling point by Therm. (a) in liquid.	Distillation.			
							Fahr.	Cent.		Volume distilled under 215° C. (liquid)	Highest temperature (liquid).	Volume distilled.	Time.
BURNING OILS.		per gallon.					deg.	deg.	deg. C.	per cent.	deg. C.	per cent.	hrs.
American Royal Daylight ...	Light straw ...	4d.	·811	·00067	·00084	·47	76	24·5	144	25	230	35	3
„ Ordinary	„ „ ...	3¾d.	·791	—	—	—	75	24	145	29	223	36	3
„ Water-white	Colourless ...	5d.	·780	—	—	—	108	42	150	55	216	55	4
„ Tea Rose	Light straw ...	4½d.	·797	—	—	—	83	28·3	150	22	243	37	3
Russian Ordinary (Russoline)	„ „ ...	3½d.	·824	·00068	·00085	·43	82	27·8	151	30	221	36	3
„ Lustre	„ „ ...	4d.	·825	·00072	·00089	·45	—	—	—	—	—	—	—
Broxbourne Lighthouse	„ „ ...	5½d.	·810	·00072	·00089	·44	152	66·7	165	1st drop	243	55	3
											270	90	2
											300	100	3
INTERMEDIATE OILS.													
American Mineral Sperm......	Straw	8d.	·833	—	—	—	—	—	195	0	300	5	3
Storrar's Scotch Gas-oil	Reddish brown	2½d.	·843	—	—	—	—	—	195	0	283	5	3
Scotch Intermediate Shale Oil	Clear brown...	2½d.	·846	—	—	—	—	—	195	0	291	18	2
Light Lubricating Oil	Clear brown...	2½d.	·853	·00068	·00080	—	225	107	195	0	285	18	2

On the other hand, if I take the light, volatile, and dangerous oil called benzoline, which is not readily procured in town, except in small quantities from chemists, you see it does not extinguish the lighted taper. On the contrary, inflammable vapour is given off from this oil at the temperature of the room, and the vapour ignites coming in contact with the lighted taper held near the oil, when the flame is a few inches above the surface of the oil, and before it actually touches the liquid. It is obvious that the vapour that arises from this light dangerous liquid is highly inflammable, and explodes often when least expected, causing serious damage and mischief. This is certainly not a safe oil for ordinary use; it is petroleum spirit, or, perhaps, more correctly speaking, an inflammable liquid.

FIRE TEST.—BURNING POINT.

The ordinary burning oils do not give off a large amount of vapour at the atmospheric temperature, even in summer. However, if the temperature of, say, "American Royal Daylight, be raised sufficiently by holding the lighted taper close to the surface of the oil, after some time enough vapour will be given off to ignite and produce a blue flash. This temperature, accurately determined as we shall see presently, is called the flashing point of the oil. If we heat the oil still further, we reach the *burning point*, or *ignition point*, at which the liquid mass of oil is actually ignited and burns steadily. This rough and ready way of gradually heating a little oil in a tea-cup about three-quarters full of oil, placed on warm water in a vessel, was one of the earliest methods of testing the inflammability of oils.

FLASHING POINT.

A thermometer, just immersed in the oil, is held in one hand, and a lighted taper in the other; and it is found that *the temperature*, at which the oil vapour comes off fast enough to give a *blue flash* depends on, first, the time taken in heating the oil; second, the exposure of the oil cup to air draughts blowing on the surface of the oil; third, the size and nature of the test flame, and the distance it is held from the surface; and, fourth, the duration and frequency of the application of the flame. There is, perhaps, no more important test of oil, as regards safety in transport and use, than this one for finding the *flashing point*. This flashing point test is associated with the name of our chairman, who has done us the honour to pre-

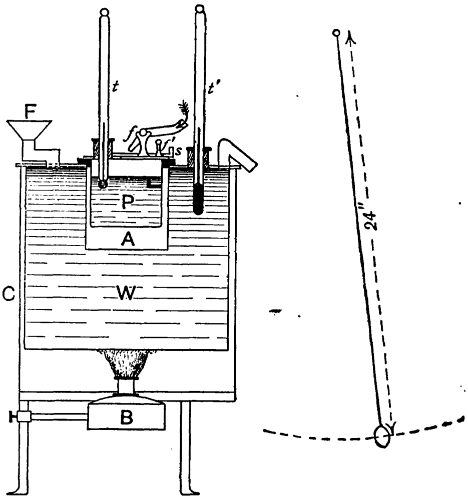
side to-night; and I am of opinion there is no other one man who has done so much as Sir Frederick Abel to insure the safety of the public when using petroleum oil. The "flashing point" of an oil is defined as the temperature at which the oil begins to give off any sensible quantity of inflammable vapour, when enclosed in a certain specified way, so that the vapour burns with a blue flash when a small flame is brought into contact with it. Clearly, the lower the flashing point—that is, the lower the temperature at which the oil gives off a notable quantity of inflammable vapour—the more dangerous the oil is in transport, storage, and use.

We have already seen that petroleum is a complex mixture of hydro-carbons having various boiling points, so that a sample of refined petroleum is usually made up of a graduated series, from comparatively light oil up to heavy oil. Now, we must draw the line somewhere between the petroleum spirit, which is dangerous, and the oil, which is safe; and both experience and legislation founded thereon have arrived at the conclusion that 100° Fahr. for the open test, or, more recently, 73° Fahr. for the close test, is the standard flashing-point, above which an oil may be considered safe, but below which an oil is undoubtedly dangerous in this country. Even a very small per-centage of light oil mixed with a heavier oil gives off vapour rapidly, and can be readily detected by its effect on the flashing-point. Thus, an oil flashing at 113° Fahr., by the open test, is found to flash at 103° F. when mixed with 1 per cent. of naphtha, and at 59° F. with 10 per cent. of the light oil, making the mixture a dangerous inflammable liquid. Indeed, the same oil, mixed with 20 per cent. of naphtha, ignites and burns at 50° Fahr. far below the temperature of this room.

Abel Test.

We have here on the table a standard instrument—the Abel test apparatus—which enables us to give an exact answer to the question, at what temperature is there a sensible quantity of inflammable vapour given off any sample of oil? The Abel close test apparatus and the method of using it are fully described in the Schedule I. of the 1879 Petroleum Amendment Act. The diagram Fig. 1 shows the Abel Tester partly in section. The outside copper vessel, C, contains the water bath, W, which consists of two copper cylinders. The bath, W, is filled by pouring water into the funnel, F, until it begins to overflow at the spout. This bath is heated by the spirit lamp, B. The oil-cup, P, is made of gun-metal or brass tinned inside, and rests upon an ebonite ring, over the air-chamber, A, and has a tight-fitting lid, on which is fixed the gas burner, the flame, *f*, being made 0·15 inch in diameter, the same size as the white bead, *f'*, on the cover. There are in the lid three holes, which can be opened by pulling out the brass slide *s*, and this motion of the slide, by means of a lever, tilts the burner so as to bring the flame, *f*, through one hole in the lid just below it to the space above the oil. The thermometer, *t*, in the lid has a round bulb, just immersed in the oil, and the scale with special points marked on the ivory back. The other thermometer, *t'*, with long bulb indicates the temperature of the bath.

Fig. 1.



Abel Tester.

When applying the test, the apparatus is placed in a position not exposed to currents of air or draughts. The temperature of the water bath at the start of the test is to be exactly 130° Fahr., or 54·5° C. The oil to be tested, if above 65° Fahr., should be cooled down to 60° Fahr., and then poured into the oil-cup, P, carefully, to avoid splashing against the side, until the oil reaches the point of the little bent wire gauge inside the cup. The lid is then put on, and the cup placed in the bath, and the rise of temperature watched on the thermometer in the petroleum cup. When the temperature of the oil is about 66° Fahr. or 19° C., start testing by drawing the slide slowly open while the pendulum,

24 inches in length, makes three oscillations and close it rapidly during the fourth oscillation. In this way the test-flame is gradually tilted through a hole in the lid to the space above the oil. Repeat this operation once for every 1° Fahr. in temperature, until the vapour of the oil gives a pale blue flicker or flash, and then the temperature of the oil is noted as the flashing point. The flashing point of a sample of oil may be defined as the temperature at which the oil begins to give off an appreciable quantity of inflammable vapour when slowly heated in a closed vessel. In this country the lowest flashing point allowed for petroleum is 73° Fahr., or 22·8° C.

The results obtained by the Abel tester are satisfactory, except that slight errors come in the personal equation, from variation in the rate of moving the test-slide. In order to obviate this source of error, in the German modification, a clockwork mechanism is used, which is wound up and the trigger pressed, to move the test-slide automatically. In hot countries, the more volatile hydrocarbons come off readily by the slightest shaking of the oil, consequently it is found better to start applying the test-flame at 56° Fahr., and thus remove small quantities of vapour by the air-currents. Another difficulty is that the cover of the oil-cup gets heated by the test-flame.

For low flashing oils the air-chamber, A, around the oil-cup is filled with cold water to a depth of 1·5 inch, and the water bath, W, is filled with cold water. In testing heavy oils of high flashing point, start with water heated to 120° Fahr., and keep the spirit lamp, B, constantly under the bath.

Any variation in the atmospheric pressure from day to day slightly changes the flashing point of an oil. Experiment shows that the flashing point varies at the rate of about 2° Fahr. for every 1 inch of mercury in the barometer.

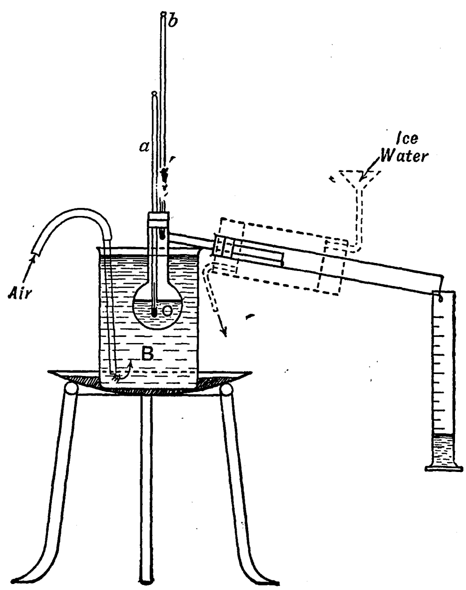
An attempt was made by Salleron and Urbain to deduce the flashing point from the vapour pressure, but this pressure was found to be different with different samples of petroleum having the same flashing point, perhaps because the samples were made up of different mixtures of hydro-carbons.

The flashing-point test enables us to ascertain whether there are very volatile and inflammable hydro-carbons present in a sample of oil. Consequently it is a very good and necessary test as to the safety of petroleum oil for storage and use. Still we cannot by this method determine the exact proportion of the more volatile hydrocarbons present, much less obtain further information as to the nature of the oils.

Fractional Distillation.

We are led, therefore, to try to find by *fractional distillation* the composition of the different petroleum oils, as regards the proportion of their more volatile constituents. In order to obtain comparable results it is necessary to use the same apparatus and work under the same conditions throughout. The same measured volume of oil taken in every case, equal to that of 1,000 grains of pure water at 60° Fahr., was heated in a glass flask, O, Fig. 2, by the steady flame of a

Fig.



Fractional Distillation Apparatus.

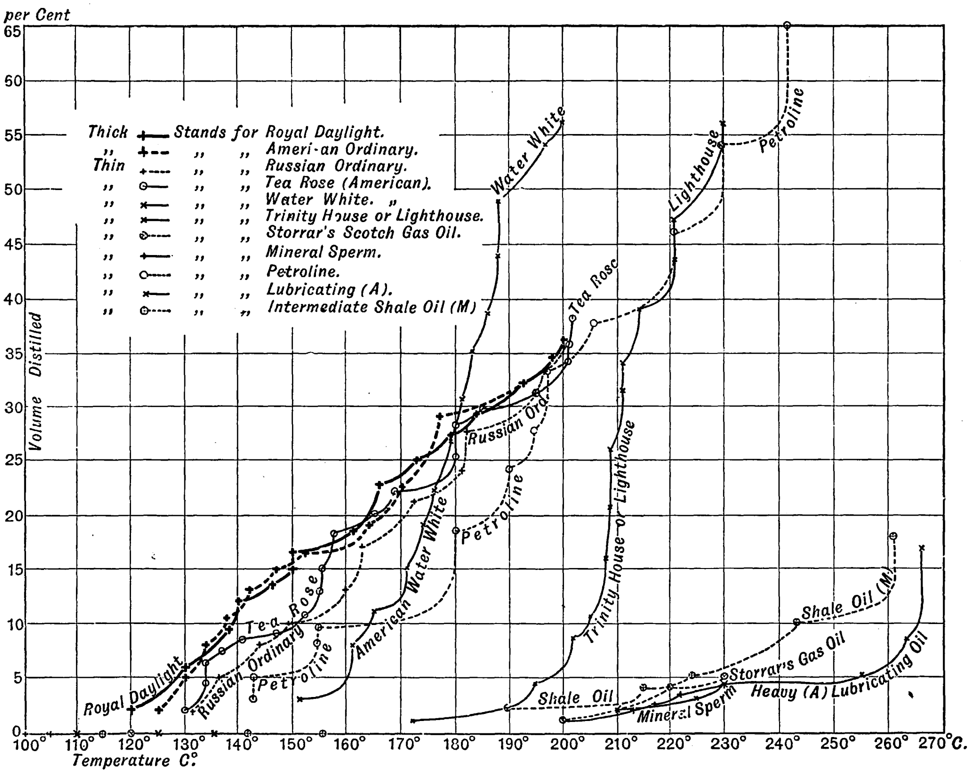
Bunsen burner, shielded from draughts. In one set of experiments the flask, O, containing the oil was completely immersed in an oil bath, B, and in another series the flask rested on the sand bath heated by the Bunsen flame. One thermometer, *a*, was kept immersed in the oil, the other, *b*, gave the temperature of the vapour at the neck of the flask, opposite the exit-tube leading to the condenser. In dealing with petroleum spirit, as benzoline, the more highly volatile hydrocarbon constituents, when driven over, might remain in the state of vapour at the ordinary temperature. Hence, ice-cold water was made to circulate round the exit tube, to cool and condense the products that came over. The tube

was slightly inclined, so that the distillate, as it condensed, trickled down the glass tube, and was allowed to drop into the graduated vessel, where its volume was measured. A current of air, forced into the bottom of the oil bath, B, bubbled up, and, acting like a stirrer, caused a continuous circulation, which maintained the temperature of the bath fairly uniform throughout.

As the sand and bath is heated very gradually, the temperature of the liquid oil in the flask was noted when boiling commenced vigorously, and the indications of both thermometers observed simultaneously.

Although the temperature of the liquid is steadily increased, the mercury in thermometer, *b*, frequently falls, when the oil vapour comes off slowly, and condenses on the bulb. Then the heating flame is slightly raised, in order to drive off more vapour, and so urge up the mercury in thermometer, *b*. The difference between the temperature of the liquid oil, as given by thermometer, *a*, and its vapour by *b*, varies with the rate of evaporation, and be-

FIG. 3.



FRACTIONAL DISTILLATION CURVES.

comes less and less as the temperature increases. This difference also depends on the size and shape of the flask, the quantity of oil used, and the heating flame, and other things which control the rate of evaporation.

With a homogeneous liquid, such as water, heated by a steady flame, this difference between the readings of *a* and *b* remains constant, since the water is at 100° C. or 212° F. all the time, but not so with petroleum.

In the case of oil, the distillation takes place in steps or stages, and in order to continue the evaporation, it is found necessary to increase the heating flame when distillation ceases at one temperature. Sometimes the rise in temperature takes place rapidly from one stage to the next, showing a very marked difference in the boiling points of the various constituents of the oil; at others, the changes are slow and gradual.

This property of oils may be more clearly seen by the diagram of distillation curves, Fig. 3, in which the heights of points represent the volume of oil distilled, and horizontal distances

the vapour temperatures (b) of the different fractions coming over. For instance, in the case of a simple substance, say pure water, the distillation curve would be a vertical straight line at 100° C. (212° Fahr.), indicating that under standard atmospheric pressure, water boils at 100° C. until the whole mass is evaporated, and the temperature does not go higher. Any increase in the heat applied merely causes more rapid boiling and distillation. Now, the more homogeneous an oil, the greater the proportion of it that will boil off within a given range of temperature; that is to say, the closer together are the boiling points of the various constituents, and, consequently, the more nearly will the distillation curve approach to a vertical straight line like that for pure water.

The curve for Broxburn Lighthouse or Trinity-house oil (Fig. 3) shows that this oil distils over within a comparatively limited range of temperature between 150° and 300° C.; that is, it distils between 302° and 572° Fahr., and so fulfils the Trinity-house conditions. On the other hand, "Royal Daylight," the ordinary burning oil supplied by the Anglo-American Oil Company, distils at a very low temperature (see Fig 3. and Table I., p. 964), and distils gradually, giving off fractions of oil which seem to increase regularly and uniformly both in boiling point and specific gravity, obtained through a wide range of temperature.

"Royal Daylight" oil boils about 140° C. (by thermometer a in liquid), and begins to distil about 160° C.; at 215° C. only 25 per cent. is distilled, at 230° C. 35 per cent., at 300° C. only 76 per cent., at 340° C. 82 per cent. On further urging the heating flame, there was a check on the evaporation indicated by the reading of thermometer b falling rapidly, although that of a was rising at 358° C., the utmost limit of the thermometer used. The fraction that distils at any one temperature varies slightly with the rate of heating. Evidently these fractional distillates consist of different hydrocarbons that are driven off at their various boiling points. By comparing these distillates we gain a pretty exact notion of the relative amounts of light and heavy products that are mixed together in the oil.

Take another American burning oil, known as water-white (see Fig. 3 and Table I., page 964). A large proportion of the vapour comes off with comparatively small change in the temperature. Thus, between 180° and 215° C., by thermometer a in liquid, 55 per cent., or more than half the oil, is given off. The boiling points of the constituents indicate that water-white oil approaches more closely to a substance of simple constitution, like water, than the other oils. Indeed, Mr. Boverton Redwood has pointed out that, at the refineries, the first and last portions which distil over—technically known as "tops" and "bottoms"—are rejected from "water-white," so that this oil contains fewer hydrocarbons, and is, consequently, of more uniform composition and simpler constitution than the usual run of ordinary kerosene oils.

From such an examination it follows that we must regard these refined petroleum oils of commerce as mixtures of a number of hydrocarbon distillates, each fraction having a more or less well-defined boiling point and specific gravity. Consequently, we may mix together an oil having a low flashing point and specific gravity with a very heavy oil, so that the mixture shall have a specific gravity of another very different substance. By fractional distillation we find the range of temperature within which all the oil distils, and obtain useful information regarding the volatility, boiling points, and amounts of the various constituents.

In any such distillation "cracking" may occur to the oil condensed near the exit tube, which falls back into the hot liquid and is decomposed into lighter products. Still, this action may be very slight, because when the condensation was reduced by immersing the neck of the flask in an oil-bath (Fig. 3), it was found that the per-centage of oil distilled under any given temperature (a) of the liquid, say 215° C. (Table I.) agreed exactly with that obtained by heating the oil in the same flask on the sand-bath without using the oil-bath.

Specific Heat.

When we come to consider in oil-engines the quantity of heat necessary to convert oil into vapour, in the vaporiser, we must know, 1st, the specific heat of the oil, in order to find the amount of heat required to raise the temperature of the oil in the liquid state; and 2nd, the latent heat of evaporation of the oil and oil mixture. By specific heat is meant the number of units of heat necessary to raise unit weight (1 lb.) of the liquid oil one degree in temperature. From experiments made on the burning oils between 10° C. and 20° C., I find the specific heat of these liquids about

0·4 to 0·5; as given in Table I., p. 964, are rough approximations.

LATENT HEAT.

The latent heat of evaporation of any burning oil is not a very definite quantity, because of the want of uniformity in the composition of these oils. Moreover, the more volatile fractions pass off readily, rendering it necessary to evaporate the whole of the oil taken, and even then the last dregs which have to be driven off are likely to leave a slight tarry or gummy deposit, so that for a given sample of oil only a mean or average value of the latent heat can be taken as compared with that of water. The figures obtained are given with every reservation as the result of preliminary experiments. Evaporating in the open air with heat applied by means of a steady flame, the latent heat of "Royal Daylight," appears to be about 1·09 times that of water, "Russolene" somewhat lower, and "Lighthouse" considerably greater. Now 1 lb. of water, at 100° C., will take 537 units of heat to convert the whole mass into steam at 100° C., hence the average latent heat of burning oils is about 1·12 × 537, that is, about 600 (lb. Centigrade) units or 1,100 British thermal units.

We must bear in mind that petroleum spirit evaporates very readily without leaving any deposit. When heat is steadily applied by a constant gas flame, it is found that a given quantity of heat evaporates nine times as much of petroleum spirit (sp. gr. ·680) as of water under the same conditions at atmospheric pressure, that is, the average latent heat of this spirit would appear to be only about one-ninth that of water. We must bear in mind that, for this comparison, we have to convert all the oil into vapour, inasmuch as a smaller amount of heat is required to evaporate the first half of the oil than for the heavier and less volatile portions left liquid to the last. Thus, the average latent heat of the heavier part of the petroleum spirit, towards the end of the evaporation, approaches the latent heat of water.

VOLUME OF PETROLEUM VAPOUR.

However, the spirit expands to about one-fifth the volume of vapour that water yields. Hence a given amount of heat can produce nine-fifths or 1·8 times the bulk of spirit vapour from petroleum spirit of specific gravity ·680 that it would of steam from water, at ordinary atmospheric pressure.

The increase in bulk from the liquid to the vapour, when taken at atmospheric pressure and standard temperature 0° C., is also much greater, in the case of light spirits, than of the heavier oil. With Victor Meyer's apparatus, and an air bath at 300° C., I find, for Russolene oil of specific gravity ·824, that the volume of air displaced by the amount of vapour formed at this temperature, when reduced to standard atmospheric pressure and 0° C., shows that the oil expands to about 310 times its bulk in changing into vapour. Experiments with various burning oils indicate that the bulk of the vapour formed is about 300 to 350 times the volume of the liquid at atmospheric pressure.

VAPORISATION OF OILS.

The *evaporation* of petroleum oil is usually effected, first, by heating the oil, and, at the same time, mechanically removing the vapour from the surface of the boiling liquor. In practice, the oil vapours are best carried off by superheated steam, which is allowed to escape from perforated pipes over the surface of the oil. The particles of oil vapour are kept hot by the steam, which carries them away mechanically, and so prevents the oil vapours condensing and falling back into the hotter liquid, to become "cracked" or decomposed. This plan is found to work better than that in which the vapours are removed by the ordinary vacuum pump and condensing coils.

I have determined the loss in weight of some heavy oils by prolonged heating at low temperatures, keeping the oils exposed to a slight air draught, and allowing free evaporation. Known weights of oil were taken in shallow platinum and nickel dishes, about three inches diameter across the top, and gently heated on a sand-bath by a very small, steady gas flame. Evaporation was encouraged in this way, the temperature being kept constant for an hour and a half. The proportion of volatile constituents present in three samples are given in Table II., p. 970.

Secondly, further evaporation is facilitated by churning or agitation, and exposure of a large surface of the oil to atmospheric air at the ordinary temperature.

A simple experiment will show the relative fractional evaporation by blowing a current of air through three samples of oil under exactly the same conditions. Take a known weight of Broxburn Lighthouse oil (specific gravity ·810) in a platinum dish. Connect a large flask by a piece of india-rubber tubing to a fine piece of glass tubing held in the oil Now blow the full of the flask of air very slowly, say in 15 minutes, so that it bubbles

TABLE II.—EVAPORATION.

Name of Sample.	Specific Gravity at 60° F. (15·5° C.).	Constant Temperature. (Centigrade.)	Time of Evaporation. (Hours.)	Per-centage Loss in Weight.	Total Per-centage Loss in Three Hours.
		Degrees.			
Broxbourne Lighthouse Oil......	·810	40 to 45	1·5	1·63	6·90
		60 to 65	1·5	5·27	
Scotch Intermediate Shale Oil ..	·846	40 to 45	1·5	1·12	3·57
		65 to 75	1·5	2·45	
Lubricating Oil	·853	40 to 45	1·5	1·00	2·96
		60 to 65	1·5	1·96	
		Steam Bath (95)	3	12·42	12·42

up through the oil without spurting, by allowing water to flow down into the flask, driving out and displacing the air. The loss in weight of the oil, due to evaporation, will be very small—perhaps about 0·3 per cent. Next, try exactly the same treatment on Royal Daylight oil (specific gravity ·797), and the loss is 2 per cent. Then take the same weight of benzoline (specific gravity ·700), and blow the same flask full of air through it in 15 minutes under the same conditions, and the loss may be about 25 per cent. By continued blowing of air through the benzoline, the greater part of it may be evaporated without the application of heat.

AIR CARBURETTORS.

There are various air-gas machines, or air-carburetting contrivances for saturating atmospheric air with highly inflammable petroleum vapour, by passing it through gasoline, benzoline, or petroleum spirit. The mechanical arrangements usually consist of (1) a blower, air-pump, or fan, driven by falling weights, like a clock, or otherwise, to force cool air over or through gasoline; and (2) the "carburettor," or chamber containing the gasoline in shallow trays, to have large surfaces of contact between the air and volatile liquid. Sometimes the gasoline is formed into fine spray by paddles or vanes rotating in a drum, through which the air is forced.

In these air-carburettors it is vapour, not gas, that is formed, and, like all vapour, it condenses when reduced in temperature or subjected to pressure. Moreover, the lighter constituents of the gasoline pass off first, leaving the heavy oil, cooled by loss of the

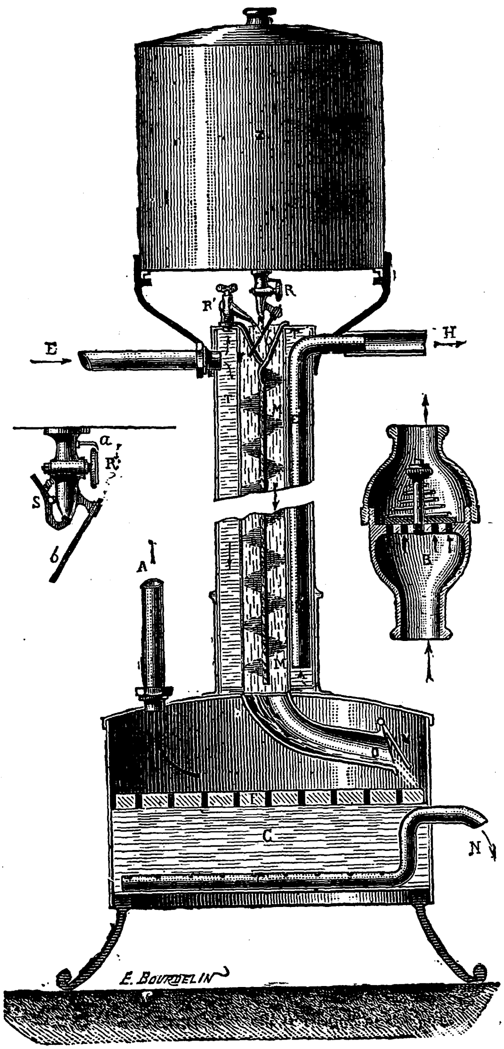
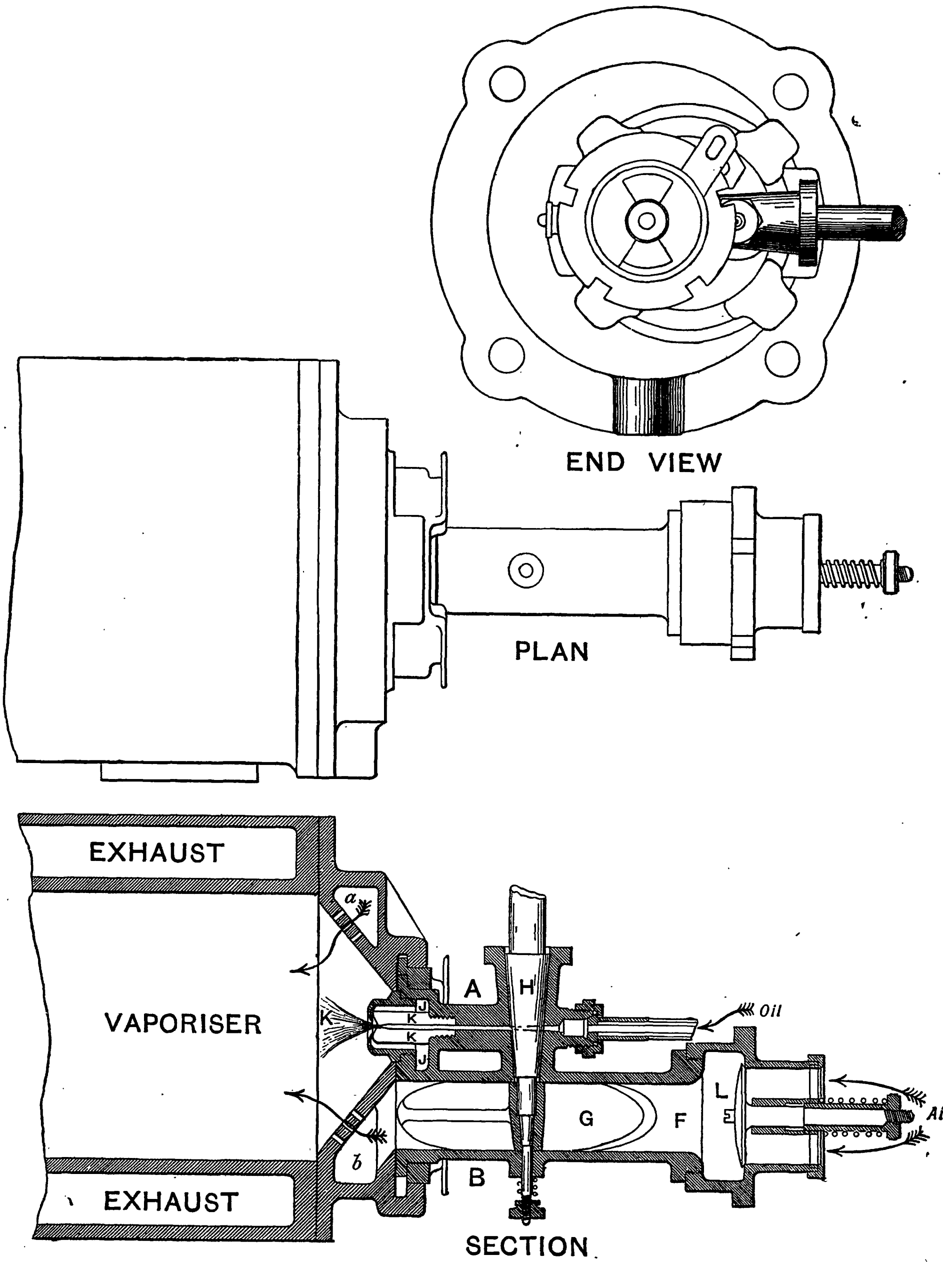


FIG. 4.—SIMPLEX CARBURETTOR.

heat absorbed in evaporation, and this thick oily residue left behind is practically useless except as fuel.

Air charged with gasoline vapour is burned for lighting purposes, and sometimes used instead of gas in gas-engines.

FIG. 5.



PRIESTMAN SPRAY-MAKER.

SIMPLEX CARBURETTORS.

The Simplex Carburettor (Fig. 4, p. 970), employed with the gas-engine of Messrs. Delamare-Deboutteville and Malandin, of Rouen, consists of a cast-iron vessel surrounded by a water-jacket, T, through which the hot water passes from the cylinder-jacket by the pipe, E. A thin stream of oil trickles from the oil-tank, Z, by the graduated cock, R, and mingling with a

stream of hot water from the cocks, the mixture falls on the spiral horsehair brush, M. The oil vapour, water and oil, pass through D into the separating chamber, where the perforated cork float, F, prevents splashing, allows vapour, and not spray, to pass into the engine cylinder, by the pipe, A, and through the safety non-return valve, B. The water overflows by the siphon, N, and carries with it the mineral and vegetable constituents of the refuse oil, which would tend to produce incrustation, if burned in the engine cylinder.

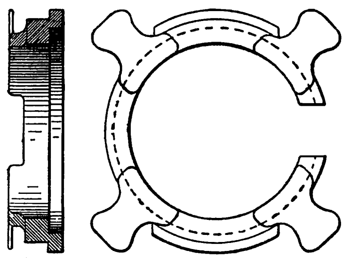
The highly volatile hydrocarbons in gasoline and benzoline used in all these air carburettors are very dangerous, and I do not recommend their use with gas engines.

Priestman Spray Maker and Vaporiser.

However, through the kindness of Messrs. Priestman, we have on the table an apparatus, by means of which the heavy and safe burning oils of commerce, as "Royal Daylight" and "Lighthouse" oil, may be finely divided up into spray, heated, vaporised, and mixed with air, ready for use, before entering the cylinder of the internal combustion engine.

In the Priestman spray-maker and vaporiser (Fig. 5, p. 971), specially designed to prepare ordinary burning oils, so as to avoid clogging in the engine, we have, as the result of many careful and laborious trials, a neat and simple combination of the two methods of treating the oil, namely—(1) spraying the oil, and then (2) evaporating the exceedingly fine spray cloud by heat. These functions are performed by the spray maker and the vaporiser shown in section (Fig. 5), joined together at A B, and may be readily separated by the wing-nut (Fig. 6), when

Fig. 6.

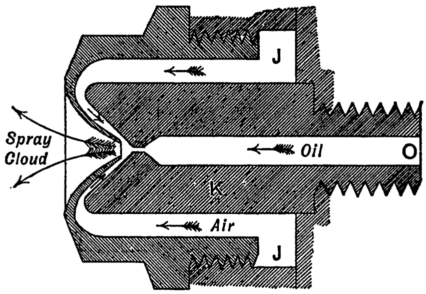


Wing Nut.

it is desired to examine the passages and spraying-nozzle, K, Fig. 5. This nozzle, K, being the most important organ in the engine, is shown in Fig. 7, nearly twice actual size. The mouth-piece is re-entrant and conical, so that the air coming from the annular space, J, turns through more than a right-angle, and converges to the point of issue of the oil-jet. The air, slightly compressed, from 8 lbs. to 12 or 14 lbs. per square inch above atmospheric pressure in top of the oil-cistern of the engine, enters the passage, J, to the nozzle, and meets the oil which has been forced by the same pressure of air-pump from the bottom of the oil-cistern, through another pipe and plug, H, Fig. 5, to the passage, O, in K, Fig. 7. The oil-jet is thus completely broken up by the air forced upon it, and comes out of the mouth-piece in the form of a hollow cone or spray-cloud of particles so finely divided as to be suspended in the air.

A simple experiment will illustrate this action. Turn off the air supply, and the small, unsprayed oil-jet is forced out by the pump in

Fig. 7.



Priestman Spraying Nozzle.

an unbroken stream, which is not inflammable, and is not ignited by the flame of the burning taper touching it.

Next, turn on the air-supply to nozzle. This air meets the oil-jet at the same pressure, and thoroughly breaks it into fine spray. The fine particles of oil-spray so formed are intimately mixed with the air, and rise in a cloud, and can be readily ignited, burning with a beautiful bright flame, no smoke being formed. (Experiment shown).

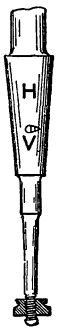
On the other hand, if the quantity or pressure of air be reduced, so that the oil-jet is not completely broken up, you will see some of the heavy particles of oil falling below the spray cloud, and when ignited it burns with a smoky flame.

Again, turn on the air at proper pressure, blowing across the oil-jet, and, you observe, so finely divided is the oil, and intimately mixed with air, that it remains suspended,

and when ignited, burns with a beautiful clear flame, showing complete combustion. (Experiment shown.)

In the working of the oil engine the spray-cloud is heated in the vaporiser, Fig. 5, by the exhaust gases. These hot products of combustion from the previous charge are led around the vaporiser before being allowed to escape, and heat the mixture of oil-spray and air inside the vaporiser to about 170° or 300° Fahr., and thus convert the greater part of the finely divided oil into vapour. Besides the air forced from the oil cistern to the nozzle for spraying the oil, an additional supply of fresh air is drawn from the annular passage, *a*, *b*, Fig. 5, and mixing with the heated spray-cloud and air carries it forward into the oil engine cylinder, where the mixture does duty in just the same way as ordinary coal gas and air in the gas-engine cylinder.

FIG. 8.



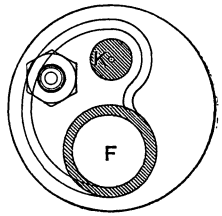
OIL-PLUG.

Experiment shows that, in order to ensure complete combustion, the exact proportions of oil and air must be maintained whatever be the strength of the charge required, and every spraymaker must be carefully tested, adjusted, and the supply passages graduated for different conditions of running, in order to completely control the action of the engine.

The supply of oil entering the spraymaker is regulated by the cock or plug, H, Figs. 5 and 8, worked by the engine governor. In this oil-plug there is a small tapering hole, Fig. 5, widening into a **V**-shaped notch on one side, Fig. 8. By slightly turning this plug, the supply of oil that passes through it can be regulated to a nicety, the wide part of the **V**-notch being always covered, so that the oil supply enters the plug only at the sharp edge of the notch, and it can never be completely shut off while the engine is running. On the same spindle, H, Fig. 5, p. 971, there is fitted a wing throttle-valve, G, which controls the amount of auxiliary air entering by the passage, F, Figs. 5 and 9. The throttle valve passage is carefully adjusted, so that the air passing through it will always be in the right proportion to the oil admitted by the **V**-notch in the plug, to form an explosive mixture, no matter how the spindle is turned by the governor at the normal speed of the engine. Consequently the amount of oil admitted is diminished or increased with the exact proportion of air, so as to form a strong explosive charge, or a weak one, according to the work being done by the engine.

When the engine-speed is very slow, far below the normal working speed, the additional air may not be drawn in rapidly enough, and the right composition of mixture for complete combustion may not be obtained,

FIG. 9.



Section through A.B.

with the results that the oil will not be all burned. The additional air, drawn into the cylinder by the motor-piston, enters the end of the vaporiser through the holes at *a*, *b*, as shown in Fig. 5 by the arrows. Before coming to the passage F, Fig. 5, through the non-return valve L, the air is cleansed of dust and grit, by passing through layers of cotton wool fixed on gauze, at the end of the air-passage, which can be closed by rotary plate or shutter. The air drawn into the oil cistern by the air pump, and used in the spraying nozzle, must also pass through layers of cotton wool, to cleanse it of dust and dirt, because the passages are very fine, and could be very easily choked up.

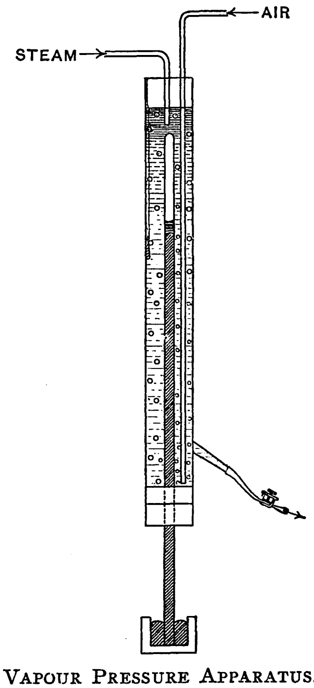
In fact, any oil-spray making and vaporising arrangement works under very critical conditions, when supplying oil vapour in the place of coal gas to the internal com-

bustion engine. The oil must be taken direct from its cistern, thoroughly mixed with the right proportion of air, heated to a nicety, and passed into the cylinder, ready for ignition, at the rate, in some engines, of two to four separate charges per second; so that, unless the arrangement for dealing with the heavy oils is correct, and works with unerring precision, there is a tendency to clog in the working parts of the engine. Many difficulties are also presented by the complex and varied character of the different burning oils and intermediate oils at present available for use in the cylinder of the common oil engine.

PRESSURE OF PETROLEUM VAPOURS.

In order to gain some exact notion regarding the behaviour of these oil vapours, when

FIG. 10.



VAPOUR PRESSURE APPARATUS.

compressed in the engine cylinder, we are led to find the relation between their pressure and temperature.

The vapour pressure of different oils, at temperatures between freezing point and boiling point of water, may be measured by means of the apparatus, Fig. 10, which consists of a barometer tube, thoroughly dried inside and filled with clean mercury. About ½ cubic centimetre of the oil is introduced above the mercury into the Torricellian vacuum at the top of the tube, which stands in a long deep trough of mercury. The upper part of the barometer tube is surrounded with a bath, which may be changed in temperature.

We may start with the bath much below the freezing point of water by adding a mixture of snow and salt. Then, by draining off this freezing mixture and adding fresh water, the temperature is very gradually raised, say to 0° C. Above 0° C., the water bath is gradually heated by steam passed into it, whilst a current of air is forced into the bottom of the bath, and allowed to bubble up, thus causing a continuous circulation, and maintaining the temperature of the bath fairly uniform throughout.

After the temperature of the bath has been kept constant for some time, note this temperature and the height of the mercury column from the surface in the trough to that of the oil above, as compared with the standard barometer.

Numerous heating and cooling readings should be taken with each sample of oil, and, as a check on the best rate of heating, the bath frequently kept at the same temperature for two or three minutes, to see whether the oil vapour had at first attained its full pressure, corresponding to the temperature indicated by the thermometer in the bath.

The observed height of the mercury in the standard barometer and in the tube containing the petroleum vapour are reduced to what they would be at 0° C., the parts of the tube in and out of the bath being taken separately. The difference between the corrected heights of mercury in the tube and standard barometer may be taken as a measure of the pressure with which the petroleum vapour pushed down the mercury column.

The absolute pressures of the vapours, from two typical samples of burning oils—"American Royal Daylight" and "Tea Rose" (see Table I., p. 964), expressed in millimetres of mercury, are shown in Table III., p. 975.

The rate of change in the pressure, due to increase of temperature, can be seen more readily from the curves (Fig. 11) obtained by plotting the results of several sets of corrected pressures, with the corresponding temperatures, on squared paper. The curve for water vapour is shown merely for the sake of comparison; and it is seen the pressure of water vapour is much higher than any of these oils give. The regularity of these curves is striking, and shows a gradual steady increase in the vapour pressure as the temperature rises. The same quantity of oil—about two cubic centi-

TABLE III.—PRESSURE OF PETROLEUM VAPOUR.

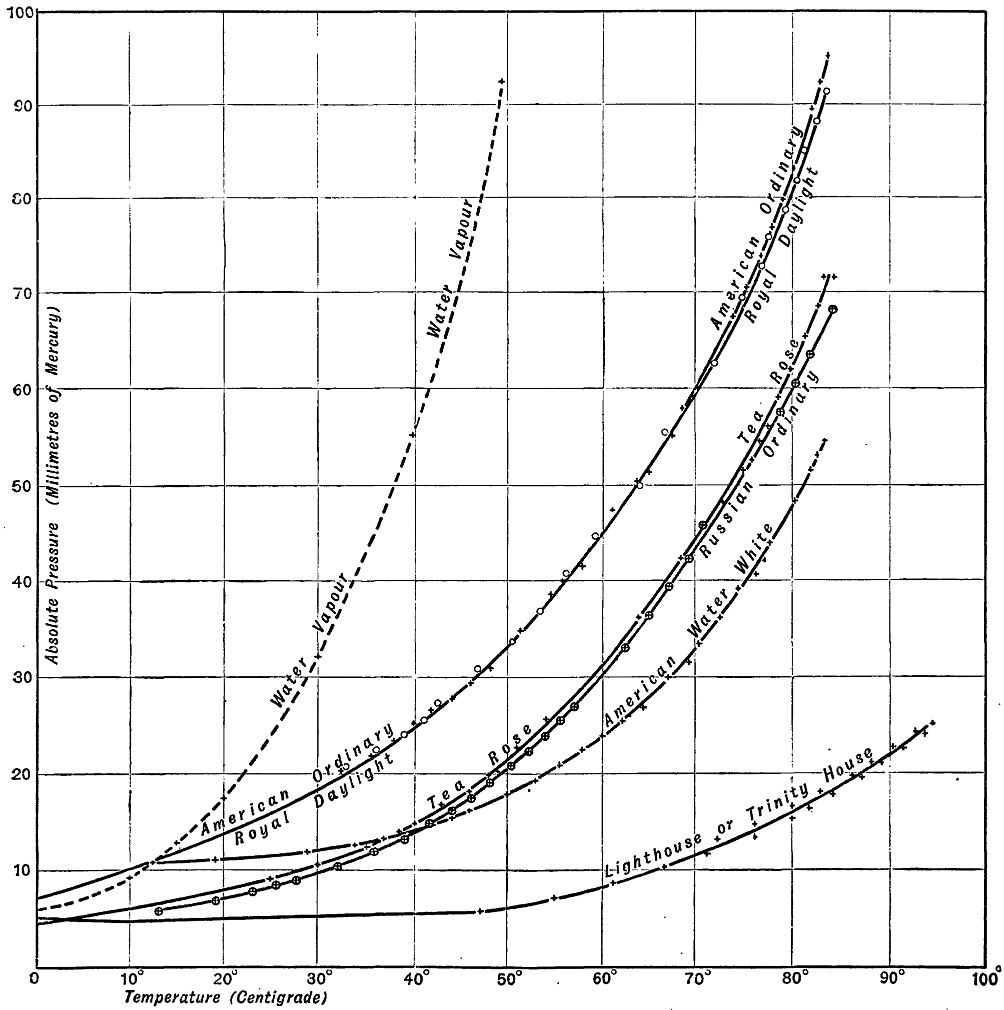
Temperature. (Centigrade.)	Vapour Pressure.	
	Royal Daylight. (millimetres.)	Tea Rose. (millimetres.)
Deg. C.		
0	7·0	3·5
5	8·1	4·3
10	9·7	5·4
15	11·4	6·5
20	13·2	7·7
25	15·5	8·9
30	18·2	10·2
35	21·1	12·0
40	24·5	14·5
45	28·5	17·2
50	32·7	21·1
55	38·1	25·0

metres—was used in each case above 20° C.; and the recent values obtained for pressures below this temperature are given in Table III.

"Royal Daylight" and "American Ordinary" practically agree, and give higher pressures than any of the other samples of kerosene.

It would appear from these curves, considered along with those from the fractional distillation, that the more volatile constituents in these two samples of oil are the same—that is to say, the "tops" are the same in both. "Tea Rose" closely agrees with the "Russian Ordinary," but contains a larger proportion of the light products. On the other hand, "Water-white" is quite distinct in its character from the other samples of kerosene, and comes nearer that of "Lighthouse Oil," which, however, gives very much lower pressure, only

FIG. 11.

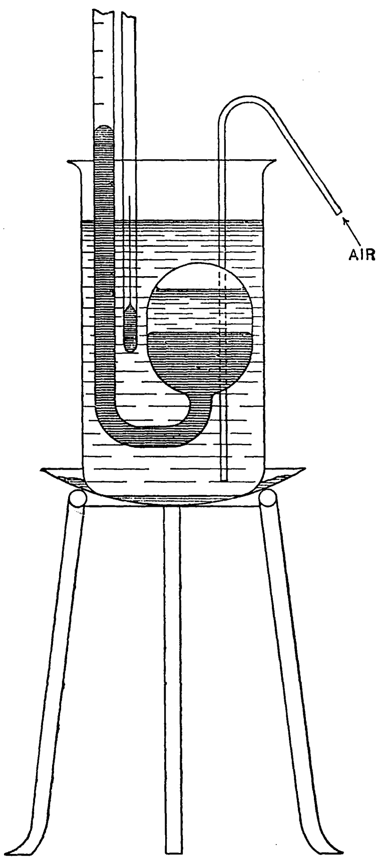


PRESSURE AND TEMPERATURE OF PETROLEUM VAPOURS.

$\frac{1}{30}$th of an atmosphere, when heated up to 95° C.

In order to investigate the pressure of these oil vapours at temperatures above the boiling point of water, a simple arrangement consists of a piece of graduated glass tube, bent into U-shape, with a bulb blown on the end, as shown in Fig. 12. The graduated tube is about a yard long, and 5 millimetres bore. The bulb is elongated egg-shaped, of 30 cubic centimetres capacity, average diameter 30 millimetres, and length 40 millimetres. Having

FIG. 12.



OIL-VAPOUR PRESSURE APPARATUS.

thoroughly cleaned and dried the bulb, it was filled with mercury, and 7 cubic centimetres of the oil was introdnced in every case, occupying about one-fourth of the bulb. The quantity of mercury was adjusted to stand at the same level in the bulb and tube when put into the bath of glycerine. The height of the standard barometer was observed, and the temperature of the room and bath noted. This bath was gradually heated by a Bunsen burner, and stirred with a current of air, which kept the whole mass of glycerine at a uniform temperature. As the temperature of the glass rose, the glass bulb and tube were first heated and expanded; after a certain interval of time, the mercury and oil took up the same temperature, and expanded accordingly. Thus, the apparent rise of mercury in the tube was the net result of the expansion of the oil and mercury diminished by the expansion of the glass. This was found to be 0·5 millimetre for every 1° C. rise in temperature. The co-efficient of expansion of mercury is 0.00018, and that of petroleum varies from ·0008 to ·0009 for 1° C. Allowance could thus be made for the rise of the mercury due to liquid expansion, apart from vapour pressure.

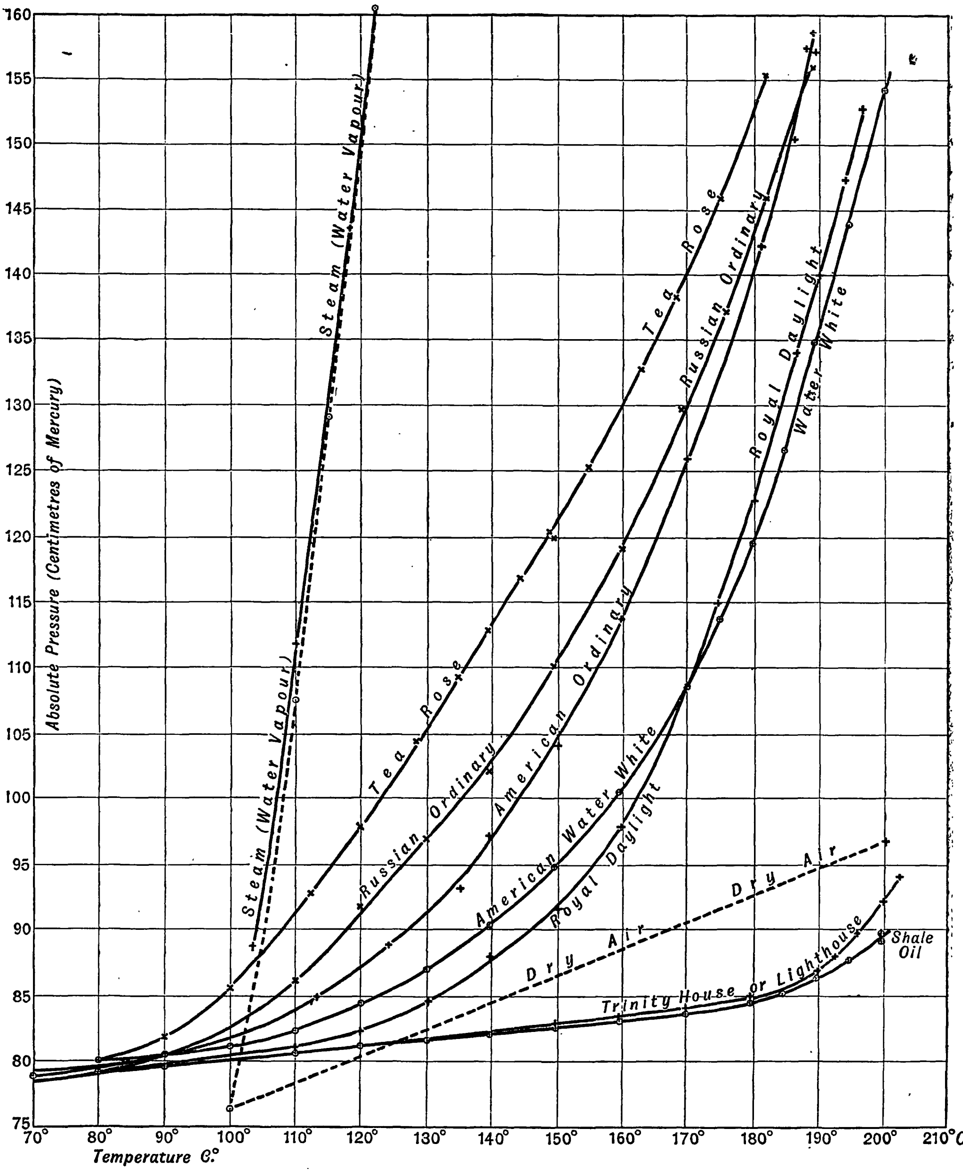
As the bath was gradually heated, the difference of level of the mercury in the tube and bulb was observed, and the corresponding temperature of the bath. Before taking a reading, the bath was kept at the same temperature for some time, and readings were taken every 5° C. Taking the mean temperature of the mercury, the observed height of the column was reduced to what it would be at 0° C. The greatest change in level of the mercury in the bulb varied from 16 to 18 millimetres, corresponding to a change of level of mercury in the pressure tube of 840 millimetres. The range was limited by the length of our graduated tube, although I did not care to push the glycerine much above 200° C.

In order to verify my work, I tried water instead of oil, and obtained the curve shown in Fig. 13 (p. 977), which above 100° C., practically coincides with that obtained by plotting Regnault's figures. Thus encouraged, and by numerous experiments, in taking oft-repeated heating and cooling readings for every sample of the kerosene, and some heavy oils, we obtained the results which, when reduced and corrected, as indicated above, and plotted on squared paper, give the curves shown in Fig. 13.

My experiments prove that notwithstanding the complex and varied character of the different oils examined, *the law according to which the pressure of petroleum vapour varies with temperature is represented by a regular curve for each oil.*

Moreover, the relative steepness of these curves is somewhat similar to that obtained by the fractional distillation curves of these oils. The petroleum vapour pressure is seen to be less than that of steam, but gradually approaching it as the oils become more volatile, until, in

FIG. 13.



PRESSURE AND TEMPERATURE OF PETROLEUM VAPOURS.

the case of benzoline and petroleum spirit, the pressure (Fig. 14, p. 978) exceeds that of steam.

Several other properties of these oils we shall discuss in this course of lectures when considering the different

USES OF PETROLEUM FOR POWER PURPOSES.

To-night we have here on the table a number of petroleum oils, ranging from benzoline up to the heavy residuum liquid. These are all used, in one way or another, in prime motors, thus :—

1st. *Petroleum Spirit, or Naphtha*, such as benzolene, which comes off as inflammable vapour at ordinary temperatures, and flashes at a temperature below 73° Fahr. (Abel close test), is wisely regarded by Act of Parliament as dangerous spirit, and is specially restricted, as regards its transport, storage, and use in this country. This naphtha, or

petroleum spirit, may be used exactly in the same way, and instead of steam, as evaporating and working agent in the type of engine precisely similar to a steam-engine, in Yarrow's spirit launch, where the naphtha-vapour is completely enclosed, condensed, and used over again.

Similar naphtha-vapour engines are fitted in small boats or spirit-launches, now built by Messrs. Escher Wyss and Co., of Zürich. Some of these launches are made of aluminium. One part of the naphtha is used as fuel to evaporate the working portion, and the oil vapour takes the place of steam as the working fluid in the engine. The naphtha used is dangerous, and not readily procured. It floats on water, and serious accidents and fires have occurred in America with this type of motor in small boats.

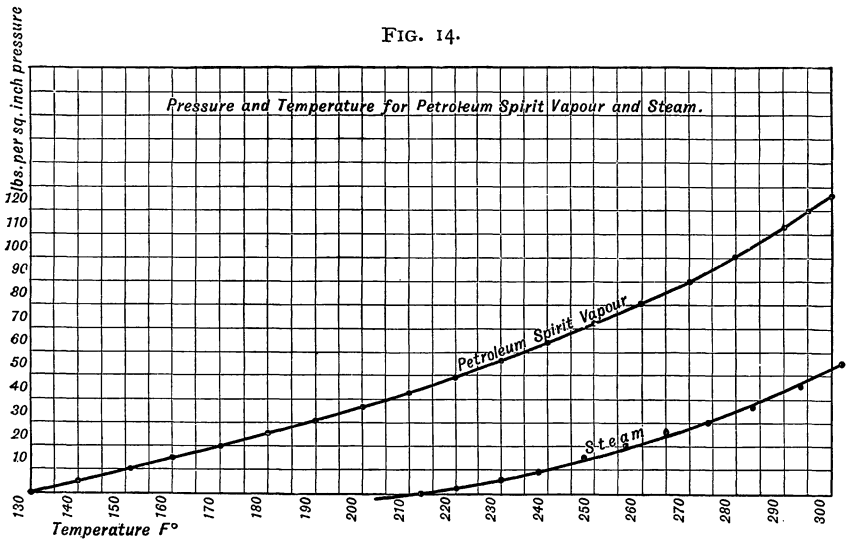
There is also a great temptation to use benzoline in the internal combustion engine, because it is easily vaporised without deposit, and burns readily.

In the petroleum spirit engines there are also many air-carburetting and heating devices, to evaporate the highly volatile hydrocarbons, which make up the lighter products of petroleum, known as naphtha or benzoline, gasoline, and shale spirit.

However, the terrible danger and risk in storage and handling of highly inflammable hydrocarbons, prohibit their common use for prime motors.

2nd. *Burning Oils.*—We find the lamp or

FIG. 14.



lighting oils, converted into vapour at low temperature, are being largely used instead of coal gas, as fuel and working agent in modern oil engines, which are rapidly replacing small gas and steam engines, because they are self-contained, and the petroleum oil can be obtained at a low price in almost any country village.

3rd. The heavy intermediate shale-oil, or partially refined petroleum, may be converted into real gas, not vapour, at high temperature, in an oil-gas producer, and this oil-gas, when cooled, is used instead of lighting gas in the gas engine.

4th. Mineral lubricating oils are largely used as lubricants in machinery, and I shall discuss the properties, tests, and uses of these oils in a subsequent lecture.

5th. There still remains behind the heavy refuse which was once considered to be useless for prime motors, inasmuch as these oils—common coal-tar, green oil, blast furnace oil, American residuum, and Russian astatki—cannot be made into true permanent oil-gas. In many places we find such oils used instead of coals, and injected as fuel with steam under steam boilers and in forges, where this liquid fuel is cheap and plentiful, and the price of coal too high.

Consequently, we are able to find a use in prime motors for nearly all the products which are obtained from the distillation of either the bituminous shale, to be had in abundance in this country, or from the petroleum oils which exist in the liquid state in the earth's crust.

Miscellaneous.

CHICAGO EXHIBITION.

The following statistical notes of the World's Fair Buildings at Chicago are given in an article by Mr. H. C. Bunner in *Scribner's Magazine* for the current month. These figures are approximately correct, within a foot or so; fractions are suppressed for the sake of simplicity; and allowance must be made for slight alterations in plan:—

The grounds are a little less than a mile-and-a-half in length. In width they are about a third of a mile at the narrow end, and about four-fifths of a mile at the broad or south end. Speaking roughly, this is about equivalent to as much of the lower end of New York City as would be separated from the upper portion by a line drawn from the foot of Canal-street and North River to the foot of Rutgers-street and East River. They contain more than half a thousand acres, exclusive of the Midway Plaisance, an annex running eastward behind the Women's Pavilion.

The Main Court, Plaza, or Cour d'Honneur is a quadrangle 2,000 by 700 feet. It contains the Great Basin, 1,100 by 350 feet; the MacMonnies Fountain, the centre-piece of a basin 150 feet in diameter; and terminates at the lake end in the Peristyle designed by Mr. C. B. Atwood, which is 60 feet high and is composed of four rows of pillars.

The Manufactures and Liberal Arts Building is 1,687 by 787 feet in size. It covers about thirty-one acres. The great main roof covers an area 1,400 by 385 feet, and has an extreme height of 210 feet. This is between 55 and 60 feet higher than the Great Arch of the Machinery Building in the recent Paris Exposition. It is only 10 feet less in height than the great chimney of the New York Steam-Heating Company. It is just 6 feet lower than the top of the spire of Grace Church, New York. It is 11 feet lower than the Bunker-hill shaft at Boston. It would hold the Vendome column mounted on a 74 foot pedestal. The seating capacity of the building is estimated at over 200,000 people. St. Peter's at Rome holds about 54,000, St. Paul's in London less than 26,000, and the Metropolitan Opera-house in New York has a capacity of 5,000 people. The entrances to this building are 40 feet wide by 80 eet high. Its ground plan is much more than twice the size of that of the Pyramid of Cheops. It is the better part of a 100 feet longer than the main span of the Brooklyn Bridge. It is nearly two and one-half times as long and more than two and one-half times as wide as the Capitol at Washington. The architect is Mr. George B. Post, of New York.

The Agricultural Building is 800 by 500 feet. Its central dome is 130 feet in height and 100 in diameter. The corner domes are between 90 and 100 feet high. The cornice-line is 65 feet high.* Messrs. McKim, Meade, and White are the architects. The statuary adornments of the building are designed by Mr. Philip Martiny. The annex to this building is 550 by 300 feet.

The Machinery Hall is 846 by 492 feet. Its annex 550 by 490 feet. These dimensions do not include boiler-house, machine-house, &c. The architects are Messrs. Peabody and Stearns, of Boston.

The Administration Building is 260 feet square. The dome is 275 feet high externally; the interna dome is 190 feet in height. That is, it is about as high on the outside as Trinity Church spire in New York. The dome of the Capitol at Washington is 287 feet in height, and internally considerably smaller than that of this building. Mr. Richard M. Hunt, of New York, is the architect; Mr. Kar Bitter, the statuary.

The Hall of Mines and Mining is 700 by 300 feet, and the architect is Mr. S. S. Beman, of Chicago.

The Electrical Building is 690 by 345 feet. The four corner towers are 169 feet high. The longitudinal nave is 115 feet wide by 114 feet high. Messrs. Van Brunt and Howe, of Kansas City, are the architects.

The Transportation Building is 960 by 256 feet, with a one-storey annex covering about nine acres The cupola is 165 feet in height. Messrs. Adler and Sullivan, of Chicago, are the architects.

The Horticultural Building is 998 by 250 feet; The dome is 187 feet in diameter and 113 feet high Mr. W. L. B. Jenny, of Chicago, is the architect.

The Women's Pavilion is 388 by 199 feet. The architect is Miss Sophia G. Hayden, of Chicago.

The Building of the Institute of Fine Arts (permanent) is 500 by 320 feet, with a dome 125 feet high. The architect is Mr. C. B. Atwood.

The Fisheries Building is over 1,000 feet in extreme length, the main building being 365 by 165 feet, flanked by two circular pavilions, each 135 feet in diameter, connected by arcades. Its water capacity is 140,000 gallons, exclusive of reservoirs. The architect is Mr. Henry Ives Cobb.

Other buildings are the Dairy Building, 200 by 95 feet; the Government Building, 415 by 345 feet; the Forestry Building, 500 by 200 feet; the Stock Pavilion, 440 by 280 feet; and the Illinois Building, 450 by 160 feet.

CHICAGO EXHIBITION FINANCE.

A budget of the assets and liabilities of the World's Fair up to October 1 is being prepared by the auditor, Mr. Ackermann. The following particulars of the

* By general agreement among the architects, 65 feet is accepted as the standard height of the main façade in most of the buildings.

financial situation have been published. It is estimated that the gate returns from May 1 to Nov. 1 will amount to £2,400,000, and that no less than £1,000,000 will be realised for concessions. The total income is set down at little less than £8,000,000 sterling. The items are as follows:—

Capital Stock	£1,120,000
City bonds	1,000,000
Exposition bonds	900,000
Congressional appropriation (5,000,000 souvenir half-dollars)	500,000
Premium on souvenirs	500,000
Gate receipts	2,400,000
Salvage	200,000
Ceremonies	30,000
Admissions to May 1	70,000
Total	£6,620,000

To this is to be added the sum realised from the concessions arranged by the Ways and Means Committee. The figures given are as follows:—

Restaurants	£500,000
Intramural railroad	60,000
Water transportation	45,000
Barre sliding railway, American glassware, street in Cairo, street in Constantinople, Eskimo village, Algerian and Tunisian village, Morocco village, Chinese village and theatre, Japanese bazaar, and other foreign attractions	120,000
Mineral water springs	60,000
Panoramas: Burmese Alps and Kilauea; Captive balloon; Hagenbeck's animal show, and other similar attractions	60,000
Cocoa and chocolate	15,000
Music halls	40,000
Miscellaneous concessions: Pop corn, glassware, pea nuts, guide books, confectionery, soda water, flowers, wheel-chairs, gum, and other like privileges	100,000
Total	£1,000,000
Preliminary receipts	6,620,000
Grand total	£7,620,000

The liabilities are estimated as follows:—

Capital stock	£1,120,000
City bonds	1,000,000
Exposition bonds	800,000
Construction	3,800,000
Operation	800,000
Total	£7,520,000

Obituary.

H. W. Freeland.—Mr. Humphrey William Freeland, who died on Sunday night, 2nd inst., at his residence in Chichester (aged 78), had been a member of the Society of Arts since 1867, and was an occasional attendant and speaker in the discussions at the evening meetings. Mr. Freeland represented Chichester in the House of Commons from 1859 until 1861, and during the Russo-Turkish war he was appointed a member of the Stafford-house Committee. He published several volumes, consisting of lectures, poems, and translations.

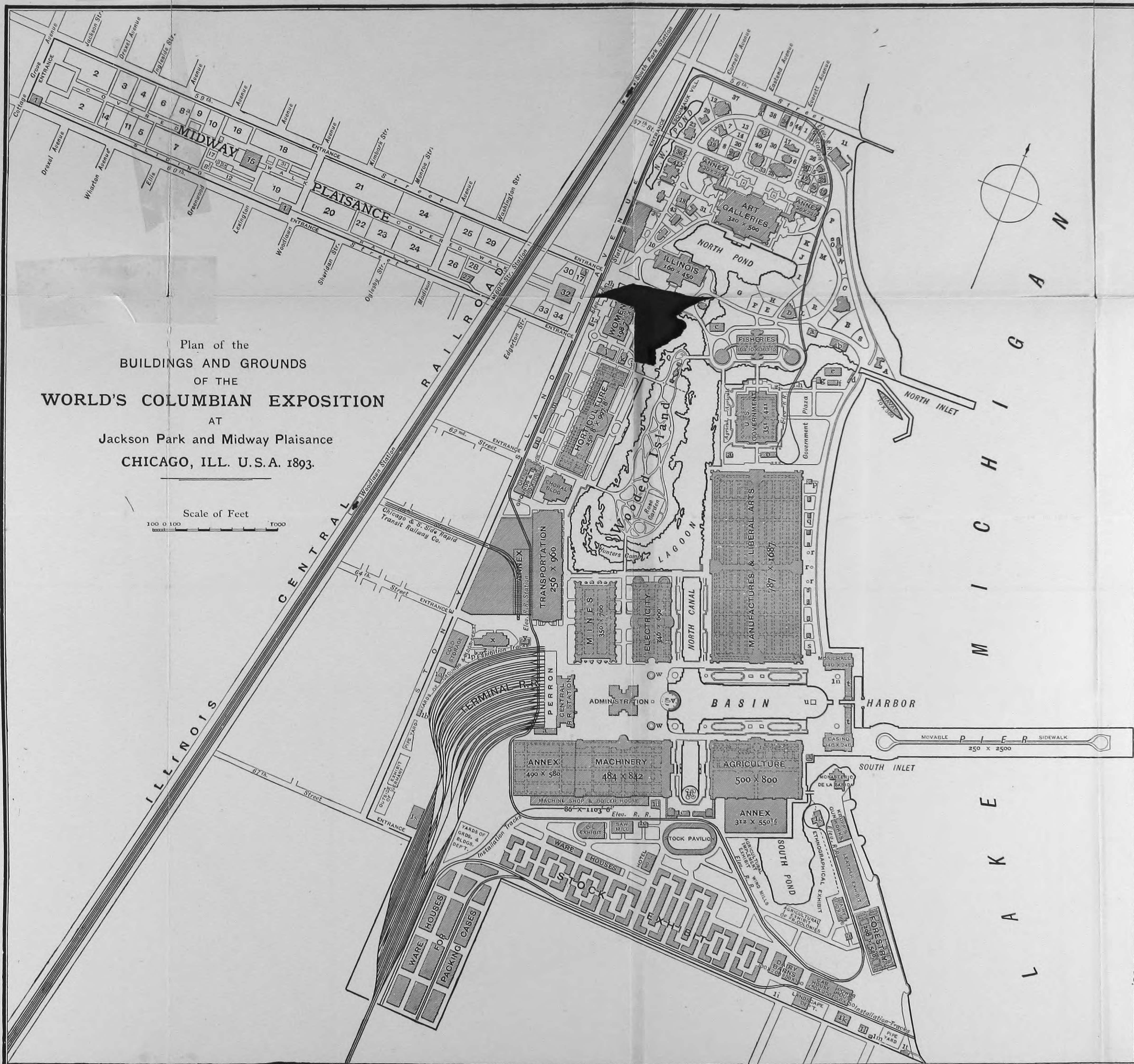
General Notes.

Kerosene Trade at Canton.—The following note respecting the kerosene trade at Canton, extracted from the last annual report of Mr. T. Watters, her Majesty's Consul at that place, is taken from the *Board of Trade Journal*:—"The importation of kerosene at Canton rose from 25,790 gallons in 1890 to 4,639,971 gallons in 1891. Of the latter amount 4,283,171 gallons were American and the rest Russian. The value at Canton of all the kerosene imported was about £144,392. This oil seems to be supplanting the native vegetable oils, not only at the large towns near the coasts, but also in the interior. Last year so much as 3,129,480 gallons were sent up country from Canton under transit pass. The junks imported direct from Hong-Kong to the various small ports, according to Kowloon Customs, 4,636,383 gallons. This shows a falling off to the extent of 2,178,066 gallons as compared with 1890. The diminished importation by junk merely indicates the transfer of so much kerosene to steamers and the Imperial Maritime Customs."

Exhibition at Rome, 1895.—An organising Committee has been appointed at Rome for the purpose of arranging for a National Italian Exhibition, to be held in that city in 1895. The Department of Fine Arts and Electricity, however, are not to be confined to the country, but will be made International.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Supplement to "Journal of the Society of Arts," October 21, 1892.]



Walker & Boutall sc.

KEY TO MIDWAY PLAISANCE.

No.
1 Depot
2 Nursery Exhibit
5 Dahomey Village, 150 × 195
6 Captive Balloon, 205 × 225
7 Austrian Village, 195 × 510
3 Indian Village
4 American or Indian Village
8a Chinese Village and Theatre 150 × 225
8b Chinese Tea House, 55 × 100
9 Morocco Exhibits, 150 × 150
10 Panorama of Volcana Kilaueau, 135 × 225
11 Roman House
12 Ice Railway 60 × 400
13 French Cider Press, 40 × 50
15 Ferris Wheel
16 Algeria and Tunis, 165 × 280
17 Fire and Guard Station
18 Street in Cairo 223 × 391
19 Moorish Palace
20 Turkish Village, 190 × 450
21 German Village, 223 × 780
22 Panorama of Bernese Alps
23 Natatorium
24 Dutch Settlement
25 Japanese Bazaar
26 Hagenbeck Animal Show
27 R.R. Station
28 Venice Murano Co.
29 Libby Glass Co.
30 Bohemian Glass Co.
32 Circular R.R. Tower
33 Adam's Empress Co.
34 Exhibit of Irish Industries
35 Model of St. Peter's
14 National Hungarian Orpheum
31 Persian Concession

KEY TO STATE SITES, &c.

No. 1 Arizona
" 2 Arkansas
" 3 California
" 4 Colorado
" 5 Connecticut
" 6 Delaware
" 7 Florida
" 8 Georgia
" 8 Mississippi
" 8 Tennessee
" 9 Idaho
" 10 Indiana
" 11 Iowa
" 12 Kansas
" 13 Kentucky
" 14 Louisiana
" 15 Maine
" 16 Massachusetts
" 17 Maryland
" 18 Michigan
" 19 Minnesota
" 20 Alabama
" 21 Missouri
" 23 Nebraska
" 24 Montana
" 25 New Hampshire
" 26 New Jersey
" 27 Wyoming
" 28 New York
" 29 North Dakota
" 30 North Carolina
" 31 Ohio
" 33 Pennsylvania
" 34 Rhode Island
" 36 South Dakota
" 37 Texas
" 38 Utah
" 39 Vermont
" 40 Virginia
" 41 Washington
" 42 West Virginia
" 43 Wisconsin
" 44 New Mexico

FOREIGN SITES, AND BUILDINGS.

A Gt. Britain	J Guatemala
B Russia	K Ecuador
C Germany	L Turkey
D Sweden	M Norway
E Colombia	N Austria
R Haiti	O Ceylon
G Brazil	P France
H Nicaragua	Q Japan
I Costa Rica	S Canada

OTHER BUILDINGS, &c.

1a Working Man's Home
1b Paint Shop
1c Loggers' Camp
1d Pump-house
1e Colonnade
1f Obelisk
1g Indian School
1h Merck & Co.'s Drugs
1i Dwelling
1k Sewage Cleansing Works
1l Oil-tank House
1m Pump House
1n Walt. M. Lowney Co.'s Pavn.
a Fire and Guard Station
b Clam Bake
c Café Restaurant de Paris
d Heliograph
e Lighthouse Exhibit
f Weather Bureau
g Life-saving Station
h Tyne Life Boats
i Anglers' Camp
j White Star Line
k Puck
l Children's Exhibit
m Green House
n Photo Building
o Military Hospital
p Van Houten and Zoon Co.
q Japan Tea House
r Music Stand
s Walter Baker & Co.
t Peristyle
u Statue of the Republic
v McMonnus Fountain
w Fountain
x Penn. R. R. Exh.
y Hygeia Cooling Plant
z U. S. Wind-engine & Pump Co.
1p Ore Yards Mining Dept.
1q W. C. Express Co.'s Barn
1r Merchant Tailors' Assoc.
1s Custom House, 100 × 200
1t Ammonia Motor

Journal of the Society of Arts.

No. 2,083. Vol. XL.

FRIDAY, OCTOBER 21, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

VIEW OF EXHIBITION.

With this week's number of the *Journal* is issued a new view of the buildings and grounds, upon which are shown recent additions and alterations, as well as a plan of the Midway Plaisance.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 19th inst. Present: Sir Richard Webster, Q.C., M.P., in the chair, Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart, D.C.L., F.R.S., Michael Carteighe, Sir George Hayter Chubb, Sir Henry Doulton, James Dredge, Professor Francis Elgar, LL.D., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Sir Edward Harland, Bart., M.P., Walter H. Harris, Charles Malcolm Kennedy, C.B., John O'Connor, William Henry Preece, F.R.S., Sir Owen Roberts, M.A., D.C.L., F.S.A., Sir Albert K. Rollit, LL.D., M.P., with Sir Henry Trueman Wood, M.A., Secretary.

EXECUTIVE COMMITEEE.

A meeting of the Executive Committee was held on Wednesday, 19th inst. Present:—Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., F.R.S., Sir Frederick Bramwell, Bart., D.C.L., Sir George Hayter Chubb, Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., John O'Connor, W. H. Preece, F.R.S., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

REPORT ON THE PROGRESS OF WORK.

By Colonel Hayes Sadler.

[*Concluded from p.* 960.]

Concessions.

The concessions already arranged include the Tower of Babel, 400 feet high, with a diameter at the base of 100 feet, which will stand in the centre of the Midway Plaisance; the exhibit of Irish Cottage Industries at the end nearest the Women's Building; the Bohemian Glass Company and the Libby Glass Company of Toledo, Ohio; Japanese bazaars, covering a space of about 225 feet square; the animal show of Carl Hagenbeck, of Hambnrg; Settlement of the South Sea Islands, including the Fijis, Samoan, Philippine, Solomon, Java, Borneo, and the Society Islands; a natatorium, 190 feet by 250 feet, and, in connection therewith, a Viennese *café* and bakery; panorama of the Bernese Alps; a German village, with representations of the houses of the Bavarian Mountains, of the Black Forest, the Hessian and Altenburg House and other typical German homes, including a German ethnological museum; a Turkish village, being the representation of one of the old streets of Stamboul, in connection with which are displayed the manufactures of Turkey, including Syria, also typical dances and other entertainments peculiar to the country; a minaret tower, from which will be heard daily the Muezzin call to prayer; Moorish palace, in which will be many illusions, camera obscura, &c., with a restaurant capable of seating 1,000 people, one of the great attractions of this building being an exhibit of 1,000,000 dollars in gold coins; street in Cairo, being a representation of the old Egyptian city, attached to which will also be mosques, dancing-halls, and many famous curiosities; Tunisian and Algerian section, showing the typical people of North Africa, their merchandise, as well as artisans at work; Ferris wheel, a wheel 250 feet in diameter swung on an axle, the largest steel casting ever made, resting upon towers 135 feet high, cars are hung at different points on the perimeter, to contain people who make the complete circuit of 250 feet, the weight of this entire revolving mass being 2,300 tons; ice railway, a practical winter exhibit, including a slide with an accumulation of ice thereon formed by artificial refrigeration; Pompeiian house, a complete representation, including

works of art; panorama of the volcano of Kilanea; section of Morocco, similar to sections of other countries; Chinese section, including a tea house, village, and theatre; captive balloon, with capacity for carrying 28 people to a height of 1,500 feet; section of old Vienna, Austrian village; East India, typical section, showing people, customs, manners, and merchandise; Dahomey village, 60 natives of both sexes, including several chiefs.

Constructions in view of the Exhibition.

The handsome city of Chicago, risen as it has in so marvellously short a time, containing now 1,500,000 inhabitants, and covering more than 180 square miles, will, with its building, parks, and boulevards, so often described, constitute in itself an attraction to visitors, while the numerous new constructions which have been and are being erected in connection with and in view of the Exhibition will add much to its imposing appearance. The new Art Institute, which is now in course of erection in the heart of the city, and is intended to be a permanent building, is fast rising above the ground; the foundations are complete, and the walls as far as the second floor at the northern end are already up, a large number of hands being employed; it will be finished in time for the opening in May next. Three-quarters of a mile further south, on the borders of the lake, the Illinois Central Railway Company are building a new passenger station, which, in point of architecture, conveniences, and solidity will, it is thought, be the finest in the country, if not in the world. As in all constructions on the borders of the lake, the foundations are on piles, which, in this instance, are driven 70 feet below the surface by a 4,000 lb. hammer till they reach the lower stratum of hard clay. The piers will be of stone, on which steel columns will support the structure. The three lower stories will be of pink granite, and the upper ones of Pompeiian brick and terra-cotta; the tower will be 200 feet high, and the area of the waiting room 150 feet by 100 feet. It will be finished by May next, and will cost £200,000. This railway company is raising its tracks in the neighbourhood of Jackson-park, beginning the ascent at Forty-seventh Street, on an embankment 130 feet wide at the top, which will obviate the dangers now existing of level crossings. The work will be completed by the winter. Trains run every few minutes alongside the lake to the Exhibition grounds, stopping at suburban stations half-a-mile apart. Steamers will also ply from the lake front, horse and cable cars now run direct to the Exhibition, while the new elevated railroad starting from Congress-street will be finished as far as the grounds. Drinking water at the Exhibition will be supplied from the beautifully clear springs of Wankesha, about 90 miles distant. In a short time the general water supply of the city, which has lately been far from what might be desired, will be derived from the new crib, through a tunnel four miles out into the lake, where, it is said, the water is quite free from sewerage contamination. A great deal has already been done in the way of paving streets, cleansing alleys, and generally cleaning and improving the city. Much has also been done towards completing the city boulevard system, which will ultimately run entirely round the city, and, with the numerous and extensive parks, afford drives of nearly 100 miles in length. Many hotels and boarding-houses, in different parts of the city, have been put up, with a view to accommodate the numerous visitors who, it is expected, will flock next year to Chicago, and others are commenced or projected, especially in the neighbourhood of Jackson-park, where quite a new city has sprung up; and it is thought that 150,000 strangers will thus be accommodated.

Financial Position.

The total receipts up to July 31 amounted to £1,937,864, derived from the following sources: capital stock, £999,475; appropriation by the city of Chicago, £900,000; interest on deposits, £10,039; miscellaneous receipts, £14,792; and liabilities, £13,568. The disbursements for preliminary organisation expenses amounted to £18,156, and up to the end of July £202,850 had been expended in general expenses, and £1,306,128 for the various disbursements which came under the head of constructive expenditure, making a total of £1,527,134, and leaving a balance in hand of £410,750.

The constructive expenditure in July amounted to £147,283, and the administrative or general expenses to £14,818, a total for the month of £161,101. The force employed by the direction that month numbered 1,743 persons, and the compensation paid was £29,315. The whole force employed on the grounds by the administration and contractors was about 8,400 hands.

The total contracts let reach to the figure of

£1,874,193, of which sum £973,056 was paid to the end of July, leaving a balance payable of £901,137. The contracts for the 13 principal buildings constructed at the expense of the Commission amount to £1,206,228, of which £796,820 has been paid. The cost is distributed as follows :—

	£
Mines and Mining Building	52,582
Electricity Building	84,900
Galleries of Fine Arts	98,528
Manufactures and Liberal Arts Building	306,760
Transportation Building	57,893
Machinery Hall	227,735
Administration Buildings	95,569
Agricultural	136,753
Forestry	14,623
Women's	26,064
Horticultural	56,940
Fisheries	42,844
Dairy	5,037

The enlarged scale on which it was found necessary to carry out the works—with a view to complete the original plans proposed, and to meet the great demands of American exhibitors and foreign Governments—has caused a larger expenditure than was at first reckoned on. Various estimates have been made with regard to the total sum which will be required before the opening of the Exhibition to the public. The balance in hand of £410,750 will be exhausted by October 21, the day of dedication ; and it is calculated that, even with the exercise of some economy, a further sum of at least £1,300,000 will be required before the gate-money is available. For this reason, a grant or loan of £1,000,000 was requested from Congress. The Federal Government had participated only so far towards the Exhibition as to appropriate a sum of £80,000 for Government exhibits, £46,000 for the expenses of the National Commission, and £20,600 for medals and diplomas, so that the decision of Congress was awaited with much interest, not only with regard to financial assistance, but as lending substantial proof of the national character of the Exhibition, and disposing of the possible contention that, because the principal funds were raised by Chicago, it was therefore a local enterprise.

After some delay, both branches of the Legislature eventually passed a Bill, on August 5, appropriating 2,500,000 dols. as a gift to the Exposition, in the form of an issue to be made of 5,000,000 half-dollar souvenir coins, and this grant has been accepted by the direction. The souvenir half-dollar will be a legal tender coin, and as evidence at once came forward that they will be sought for at enhanced value, applications having been immediately received for a certain number at a premium, the Directors, on the 12th instant, authorised their disposal at the price of 1 dol. each in sums of 50 or multiples thereof.

Though this grant may thus produce £1,000,000, the Direction are proceeding on the basis of receiving only £500,000 for the coins, and propose issuing bonds to the amount of £1,000,000, bearing 6 per cent., for the purpose of completing the Exhibition and placing the Treasury in possession of ample funds to cover all contingencies until revenues come in. It is not, however, calculated that the whole of this issue will be required ; therefore, only such portion as may be necessary will be floated.

An important condition of the Government grant, which formed part of the Bill, is that the Exhibition shall be closed on Sundays. It is thought that this condition may prove to be somewhat prejudicial to the enterprise, but, unless the question be again raised at the next meeting of Congress, when the compromise of a partial opening of the grounds is hoped for, the decision is final.

The entrance payment is fixed at 50 cents, with a small additional sum for admittance to the Midway Plaisance. For some months past the grounds have been open to visitors at an entrance fee of 25 cents, and on Sundays as many as 20,000 people have visited the buildings in course of construction. The total receipts from this source up to the 11th instant have been £12,383.

Dedication.

The date fixed for the dedication of the Exhibition has been changed from October 12 to October 21, when the buildings will be formally handed over to the nation. The former date was the date on which, according to the old system, Columbus first discovered America, and the latter date corresponds with our present calendar. The programme is not yet finally decided on, but the ceremonies will extend over three days—from October 19 to October 21—the final dedication taking place in the Manufactures and Liberal Arts Building in the presence of the President, and where seats will be provided for the guests who witness the ceremony.

On each of the three nights there will be a pyrotechnic display, which, it is intended,

shall be both magnificent and novel. A striking feature will be the procession of the centuries, consisting of 24 floats, to be drawn by cable through the waters of the grounds, and manned by groups of living figures, designed to represent peace, literature, the various arts, and other subjects illustrative of progress. On the first and second days a military parade and a civic spectacle will take place. It is proposed that 15,000 troops shall assemble, and be quartered in or near the Exhibition buildings. Invitations have been sent to all fraternal, patriotic, industrial, and civic societies in the United States to participate in the civic spectacle. This procession will pass through the principal streets of the city, and will be reviewed, as will also be the troops, by the President, the Members of the Senate and the House of Representatives, the Foreign Representatives, and the Governors of the States.

Proceedings of the Society.

CANTOR LECTURES.

USES OF PETROLEUM IN PRIME MOVERS.

By Professor W. Robinson, M.E.,
Assoc. M.Inst. C.E., University College, Nottingham.

Lecture II.—Delivered March 7th, 1892.

Petroleum Oil Engines.

The task before us to-night is to consider the use of petroleum, at once as fuel and working agent, in the cylinder of the internal combustion engine. This is by far the most important application of petroleum for the production of mechanical energy; and I feel it is almost impossible, in the time at our disposal, to fully discuss all the points I should like to bring before you on this subject. However, I shall touch on some of the more salient points, if you will allow me to deal with them rapidly.

The typical samples of oil most suitable for this purpose are generally known as burning oils, intermediate oils, and, in some cases, even light lubricating oils. Various constants, obtained from experiments on samples of these oils used in oil-engines, are given in Table I. of last lecture, *ante* p. 964.

The wholesale prices of these oils, delivered naked in London or Liverpool—that is, after allowing one penny per gallon for the barrels—are also given in Table I. We can buy American Royal Daylight oil at 4d. per gallon; American Ordinary, 3¾d.; Water White, 5d.; Tea Rose, 4½d.; Russian Ordinary (Russolene), 3½d.; Russian Lustre, 4d.; Broxbourne Lighthouse, 5½d.; Scotch gas-oils, 2½d.; Intermediate oils, and light lubricating oils at 2½d. per gallon. For towns far inland, the cost of carriage must be added; still, these prices do not prohibit the use of the oils in prime motors, although we pay very much less for the same weight of coals in this country.

We have already dealt with the characteristic properties and chief tests of petroleum. The curves plotted from the results of the fractional distillation show at a glance that whereas some of the oils give off only a little vapour slowly, and in gradual stages, throughout a very wide range of temperature, and although other samples do not commence to distil until heated to a higher temperature, yet some of these come off more quickly, and the greater part of an oil like Lighthouse is vaporised at the temperatures reached in our experiments. We must constantly bear in mind that petroleum, and even the refined burning oils, behave in a rather peculiar manner when subjected to heat. At the ordinary atmospheric temperature (60° Fahr.) in the first place, you find evaporation going on imperceptibly from the free surface exposed to the air until a certain fraction is got rid of, and then evaporation practically ceases, unless the oil is greatly agitated or heated.

Further, any one of the refined burning oils appears to consist of a mixture of hydrocarbons of nearly uniformly graduated specific gravity and boiling points, and thus widely varying volatility. It follows, from the nature of petroleum, as shown by experiment, that the

Effects of Heat

upon ordinary kerosene or burning oil, at gradually increasing temperature, may be divided into three distinct stages:—

1st. *Vaporisation*, at a low temperature, when the more volatile portions of the oil-vapours, consisting of the lighter hydrocarbons, evaporate freely.

2nd. *Cracking* takes place as the temperature of the oil is raised, in order to force complete evaporation. Not only do we find oil-vapours driven off, but at the higher temperatures some of the heavier hydro-carbon vapours are "cracked" or split up into various other hydro-carbons, yielding gas, lighter vapour,

and leaving a very slight carbon deposit, so that the greater part of the oil is converted into vapour without producing any troublesome deposit of carbon.

3rd. *Gas-making.*—On still further raising the temperature to a cherry-red heat, as in the ordinary process of oil-gas manufacture, when the oil is dropped into red-hot retorts, or passed in small quantities through highly heated coils exposing sufficient heated surface, the oil is partially or entirely decomposed and converted into real oil-gas: a fixed, permanent gas. At the same time tarry products are formed, which are usually washed out in the process of gas-making, but are troublesome in oil-engines, because these tarry products, and the deposits from them when burned, rapidly clog the valves, passages, and working parts of the engine, and bring it to a standstill.

Now it is found, in practice, that, by regulating the temperature carefully to a nicety below this gas-making stage, the ordinary kerosene oil may be split up or converted into light products and kept in the state of vapour, especially when thoroughly mixed with excess of air, which holds the vapour cloud in suspension. Experience, then, leads to the conclusion that a really commercial and successful oil-engine must use the oil as oil, and not as oil-gas, unless the tarry products are removed by some process of washing, and the oil-gas thus washed, cooled, and cleansed before being admitted into the engine cylinder.

In the next lecture we shall treat of oil-gas and its uses in the ordinary gas-engine. At present, we are dealing with the use of oil itself, and oil vapour, not gas. We should, therefore, note the arrangements, if any, in oil-engines intended to automatically control the temperature of the vaporiser, so that only oil vapour is formed.

Preparation of Charge.

When considering oil-engines, the fact should not be forgotten that we have entirely different conditions to those connected with steam or gas engines, where the working fluid, dry steam or gas, is supplied to the engine ready made; whereas, the oil-engine has to prepare and vaporise the oil for its own use. The steam boiler is relied upon to supply dry steam to the engine at the desired pressure. In the case of the gas-engine, we have simply to turn on the gas cock, and rely upon the gas manufacturer to make gas of such quality as to give equally satisfactory results in the motor cylinder, whether used for a short or longer period. But in the oil-engine we meet with an entirely different state of things, as regards supply of the working agent. The oil must be taken direct from the oil cistern, vaporised, and thoroughly mixed with the right proportions of air, for complete combustion, and passed into the cylinder ready for ignition, at the rate, in some engines, of three or four separate charges per second; so that, unless the arrangement for dealing with the oil is correctly adjusted, and works properly with precision, the tendency to clog in the working organs is very great. The engine then just becomes like a strong looking man with a poor constitution, and suffering from pulmonary troubles: it will run well for a short time, but very soon, getting choked up, refuses to work or run any longer.

Classification of Oil-engines.

Perhaps the action of the different kinds of successful petroleum oil-engines will be best understood from the above, if we classify them all under three distinct types, depending on how the oil is treated in preparing the charge.

First Type, in which the oil is *sprayed*, and heated or otherwise *converted into vapour*, and ultimately mixed with the right proportion of clean air before being admitted into the cylinder, where the charge is compressed and fired, as in the Otto gas engine—example, the Priestman oil-engine.

Second Type, that in which oil, in the liquid state, is injected into a hot cartridge at end of cylinder, where it is vaporised and mixed with the air compressed into this hot combustion-chamber, and fired, as in the Hornsby-Akroyd oil-engine.

Third Type is provided with a *vaporiser* or *gas generator*, such as a heated chamber or a heated coil, to convert a little drop of oil into vapour, or oil-gas and vapour, by means of an oil lamp burner. Then the crude oil-gas and heated products are drawn directly into the cylinder, mixed with the right proportion or slight excess of air, and the charge compressed and fired, as in the Trusty, Capitaine, Crossley, and other oil-engines.

The cycle of operations in the oil-engine cylinder is generally that of Beau de Rochas, the same as in the ordinary "Otto" gas-engine. This cycle works very well, giving more uniform steady running than in the gas-engine.

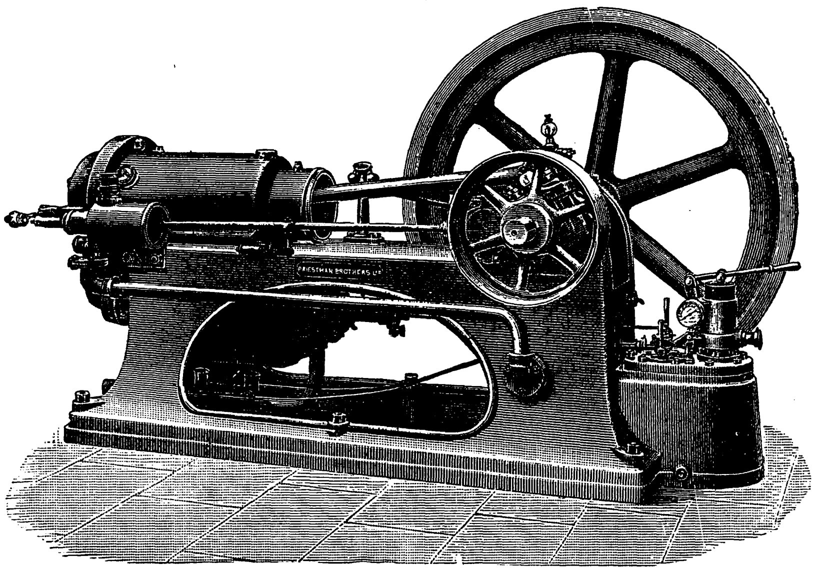
Class I.—Priestman Oil-engine.

The Priestman oil-engine (Fig. 15) is a practical success as a prime mover, and is the most common form of oil-engine employed in this country.

We have the engine here in the room, and in addition, placed on the table before you, the most important parts, namely, oil-tank and pump, spray-maker, vaporiser, heater, and igniter. As pointed out in my last lecture, the oil is forced from the tank by an air-pump, and the oil thus delivered to the spray-maker is controlled by the engine-governor, which allows the oil-jet to pass through a plug into the spraying-nozzle. (Explained by samples on table, showing section, also drawings—Figs. 5 to 9, pp. 971 and 972—in last lecture.) In the spraying-nozzle the oil-jet is broken up into exceedingly fine particles by a current of air, at the same pressure, from the top of the oil-tank. The mixed air and spray-cloud are then heated in the vaporiser by the hot exhaust gases escaping from the cylinder through the jacket around the vaporiser.

During the next suction stroke of the piston, an additional air-supply is drawn in through the spray-maker (Fig. 5, p. 971) by the wing-throttle valve passage, regulated by the governor, so as to form with the oil the right proportions for explosive mixture. This inrush of fresh air carries the charge of oil-vapour (heated spray-cloud) into the engine cylinder.

Fig. 15.



General View of Priestman Oil-engine.

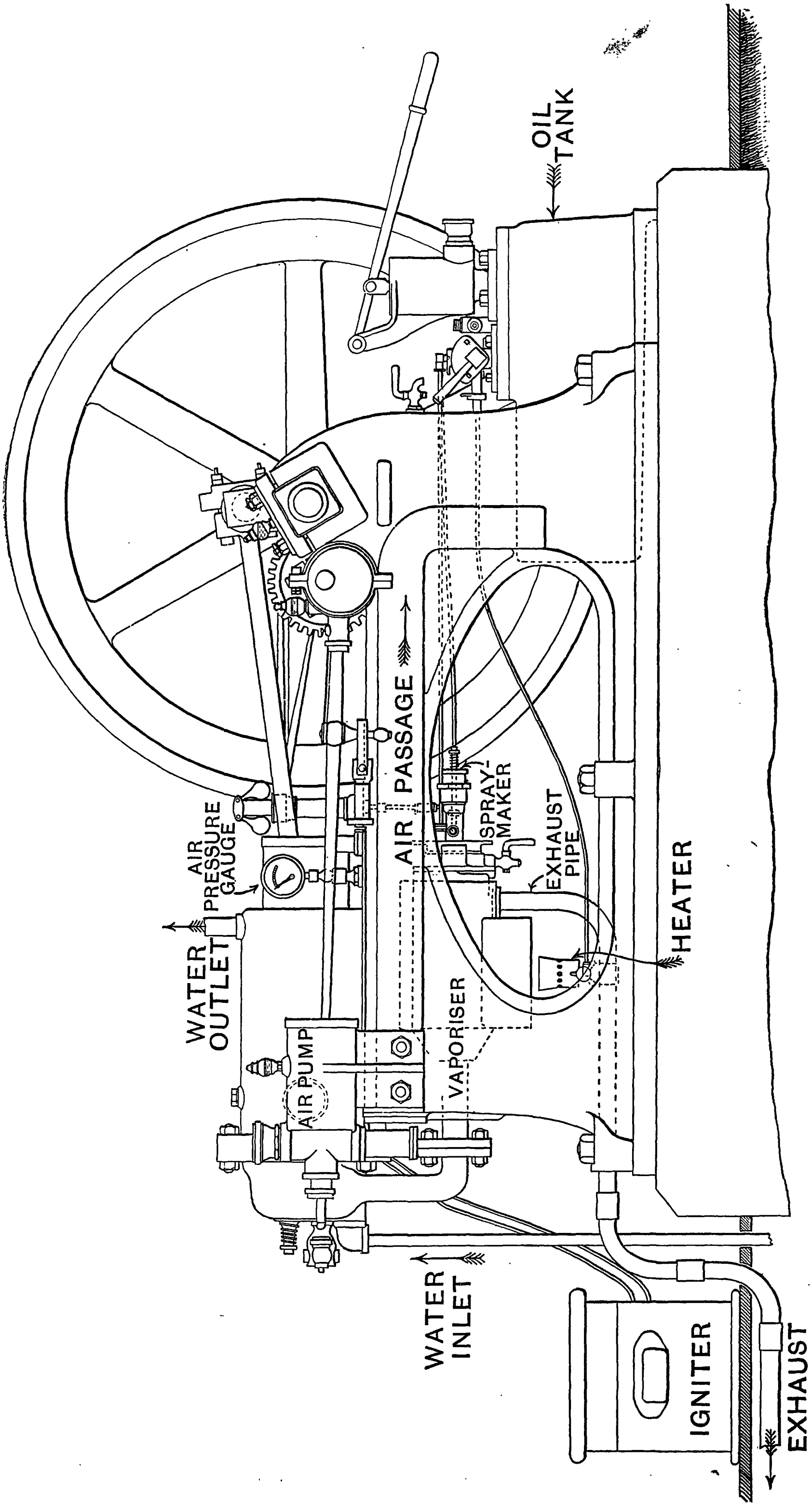
The charge, compressed during return stroke of piston, is fired by the electric spark, expands, doing useful work, and is driven out by the exhaust, the operations in the cylinder being the same as in the Otto gas-engine.

You will perhaps more easily follow this action after examining the engine itself, which we have here in the room, together with the essential parts or vital working organs on the table, explained by the drawings and wall-diagrams, Figs. 15 and 16.

Oil Supply to Engine.

The oil supply requisite for a run of a day or two is contained in an oil tank shown outside the engine-bed, Fig. 16 (p. 987). During a prolonged run this tank may be replenished, if need be, from the large oil supply tank by gravitation, as in Fig. 17 (p. 988), without ever stopping the engine. The air-pipe connecting the two vessels allows the pressure to become the same in both, and the oil flows down because of the "head" or difference of levels between the surfaces.

Fig. 16.



Essential Parts of Priestman Oil-engine.

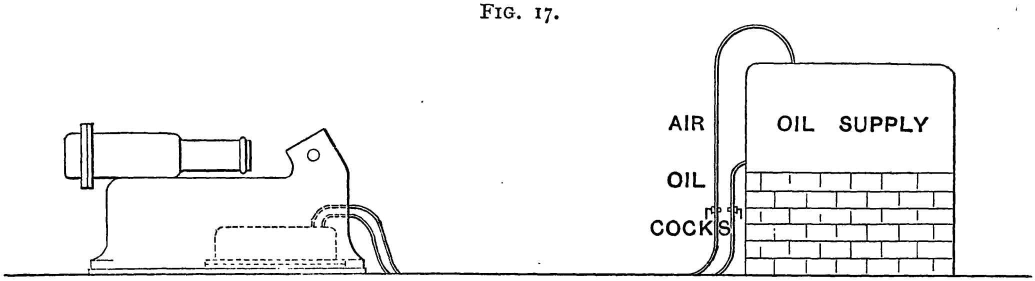
In places where this is inconvenient, the hand-pump (Fig. 18) is used to force the oil up into the small tank at the engine.

A protected glass gauge shows the oil-level in the tank.

Spray-making.

When *starting the engine*, the hand-pump (Fig. 16) forces air into the tank and delivers the oil to starting lamp or heater for vaporiser.

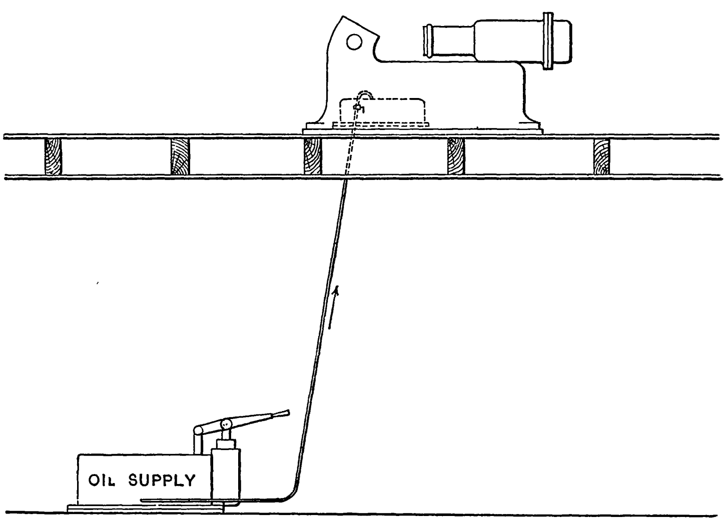
Fig. 17.



Priestman's Oil Supply by Gravitation.

Afterwards, when engine is running, the air-pressure is maintained by the small pump at the side of the cylinder driven by the eccentric and side-shaft. An escape valve on the oil-tank keeps the air-pressure constant, as shown by the gauge. This pressure is regulated for the different kinds of oil and size of engine, and is usually from about 4 lb. in small engines, to 15 lb. per square inch above atmospheric pressure in larger sizes. The air is drawn into the pump through fine gauze and a filter of cotton-wool, to clean and rid it of dust, dirt, grit, and even moisture, so that thoroughly clean dry air is used to spray the oil, otherwise the fine passages in the spraying-nozzle would be blocked or choked

Fig. 18.



Priestman's Oil Supply by Pump.

up. In fact, all the air which enters the spray-maker and cylinder is cleaned in this way.

The auxiliary air supply to the spray-maker is shut off until the engine is started, by turning a little shutter fixed on the end of the throttle-valve passage.

The oil-tank is provided with a six-way cock, arranged so that when the handle is upright the cock is closed; turned to the left,

supplies the starting lamp with oil and air; and with the handle to the right, the cock allows the oil and air to be delivered to the spray-maker in ordinary running.

In starting the engine the vaporiser is heated up by the spray-burner placed under it, and supplied by oil and air through six-way cock from the oil-tank, in which pressure, 4 to 15 lb. per square inch, is got up by hand pump depending on size of engine. You see this clear, bright, powerful flame without any smoke deposit (experiment shown) heats up the vaporiser in from 5 to 15 minutes. Then the oil and air is forced into the vaporiser through the spray-maker, and the charge is ready to be drawn into the engine cylinder, by giving the fly-wheel a few turns.

Regulation of Charge.

As explained in my last lecture, the proper proportion of oil and air is practically determined once for all when adjusting the spray-maker. The exact amount of oil passing through the nozzle is caught in this little bottle, which measures the number of drops per minute, while the air-pressure in the oil-tank is kept constant. Then the amount of air is adjusted by the wing throttle-valve, on the same spindle, to suit the oil admitted until the best indicator diagram is obtained, and when permanently adjusted the governor automatically regulates the strength of charges, to give the power required at any time and maintain the normal speed.

As you have already seen (Figs. 5 and 8, p. 971), the oil-valve is of the plug type, and the hole through which the liquid passes is cut into a **V**-shaped notch. The larger end of notch is covered, and the oil enters by the sharp end, thus allowing a wide range of regulation by simply turning the plug. Even when the engine is running light, there is always a very tiny corner of the apex of the **V**-notch open, to admit a little oil and keep the engine going. There is no complete cut-off of the oil at any time. The wing throttle-valve is fitted to a prolongation of this plug, so that both valves move together. No matter how the engine is working—with half load, full load, or running light—the governor maintains the normal speed, by admitting the charge of varying strength, but always made up of the right proportion of oil and air to form an explosive mixture.

Vaporisation.

You observe this cold spray cloud is sufficiently mixed with air to burn with a clear flame. (Experiment shown.) Subsequent heating of the finely-divided spray in the vaporiser is necessary, to thoroughly vaporise the oil before allowing the mixture into the engine cylinder.

Some of the heat from the burned products carried away in the exhaust is saved, and utilised to heat the incoming charge. About 10 or 12 per cent. of the total heat of combustion of the oil may thus be restored and utilised or regenerated in the vaporiser. The temperature of the charge on entering the cylinder varies from 170° Fahr., in a one horse-power engine, to about 258° or 300° Fahr. in a five horse-power, so that the temperature is kept well within the vaporising stage.

However, in order to ensure complete combustion of the oil, it would appear that, in some cases, fully 2·5 times more air is admitted than that which would furnish the exact amount of oxygen necessary for complete combustion, according to the chemical analysis of the oil.

Firing of Charge.

The explosive charge, prepared in this way, is drawn into the cylinder by the piston during its outward suction-stroke, compressed during the return-stroke, and fired by an electric spark between two insulated platinum points, in a brass plug screwed into the clearance space at end of the cylinder. The platinum wires pass through porcelain plugs fixed with Plaster of Paris in the brass plug, and the terminals are connected by two wires to a small induction-coil, excited by a bichromate battery contained in the "igniter" box shown (Fig. 16, p. 987) at back of engine. The battery circuit is completed at the proper moment by a knob or finger on the eccentric rod making contact between two brass springs in the shape of a fork. This fork can be adjusted and moved back by means of a screw, to give late ignition when starting.

Unfortunately, this mode of ignition was a failure in the early Lenoir engine, because of short-circuiting by water-vapour, which undoubtedly condensed on the platinum points, and prevented the spark playing across between them.

However, lest you should think that miss-fires may be caused in the same manner by deposit of oil or soot, I wish to prove, by a simple experiment, that oil-vapour acts very differently from water-vapour between the electrodes.

I hold in my hand an old ignition plug (Priestman's) which has been covered with a deposit of soot. I will put more soot on by means of this oil flame. Now observe the spark from this little induction coil still passes between the platinum points, and burns away the soot deposited on them. (Experiment shown.) Again, I shall put some oil between these dirty points, so as to bridge them across with liquid oil, which also covers the porcelain plugs. Still the spark passes, and burns away the oil (experiment shown), so that you see for yourselves it is not at all necessary to have these platinum points perfectly clean in order that the spark may play between them. Why, one of the best electric sparks we have is in the arc lamp, where the spark plays between two sticks of carbon, and the temperature is high enough to volatilise the carbon. Moreover, the electric arc may be made to pass between two carbon sticks, completely immersed in ordinary paraffin oil. Suppose there is a little deposit on these platinum points, even if this ignition plug is covered with soot, and then fixed in the engine cylinder, you will find that, after a few explosions, under ordinary working conditions the deposit is cleared away by the explosions in the cylinder, and the plug is cleaned, while the electric spark is as good as ever.

As a matter of fact, the conditions for ignition are different in the oil-engine and gas-engine. Oil is a very good insulator, consequently any slight deposit of oil between the platinum points only serves to insulate them, does no harm, and is burned off. On the other hand, water is a conductor of electricity, so that a film of water on the ignition plug short-circuits the platinum points, and makes it possible for the electric current to flow continually, along the path of smaller resistance provided by the water, instead of jumping across between the electrodes.

However, by taking in clean, dry air through the cotton wool, and clearing away any deposit of aqueous vapour formed when the engine is standing over night, so that every part is dry, the spark will act with certainty. By means, then, of this sure and powerful mode of ignition, the compressed charge is fired at the end of the cylinder, and the burning expanding gases drive the piston forward.

The charge of vapour and air is drawn from the vaporiser into the cylinder through the upper valve at the back of the cylinder, opened automatically by the suction of the piston. The lower valve for the exhaust is opened by an eccentric on a shaft geared to the half speed of crank-shaft.

The functions of the eccentric rod are threefold:—1st, as piston-rod to the little air-pump to compress air, along the air-passage into the oil-tank, and this air-pressure forces oil and air into the spray-maker; 2nd, the prolongation of the rod opens the exhaust valve every second revolution, at the right time, and allows the burnt products to escape around the vaporiser when driven out by the engine-piston; 3rd, to fire the charge, a knob or contact finger, fixed on the rod near the eccentric end, is brought between two springs, and thus completes the battery circuit at the right moment to excite the induction coil, and make the electric spark play between the platinum points inside the cylinder. As already pointed out, these contact springs can be screwed back and adjusted to make the time of explosion late, or just immediately after the piston passes the dead point.

This late ignition is a special feature in the Simplex, engine of Messrs. Delamare, Deboutteville and Malandin, of Rouen. The ignition takes place when the piston has travelled some distance on its out-stroke after compression; and it is found that more work is done with comparatively late ignition, and results in much steadier running, giving less shock to the bearings, whilst the pressure is better sustained throughout the working stroke.

The engine cylinder is cooled by a water-jacket, the water inlet being below the cylinder, and the outlet above, as shown in Fig. 16, p. 987.

You will readily understand that in the construction of oil-engines, the great point is to get economy of oil, and the best mechanical results, without clogging of the working parts, so that the engine may run steadily, without requiring attention or frequent cleaning and repairs. In the Priestman engine, clogging is prevented by thoroughly mixing the oil vapour with a large proportion of clean atmospheric air, so as always to form an explosive mixture which gives complete combustion and a clean exhaust under ordinary working conditions.

Cylinder Lubrication.

It must be pointed out, as a peculiar feature in the working of the engine, that, during the compression of the charge before ignition, a small portion of the oil vapour, coming in contact with the cylinder walls, condenses on

them, and never gets burned. Still, this condensed oil forms, in its heated state, an excellent lubricant for the piston and cylinder surface, thereby dispensing with the need of a more costly oil, and regulating the lubrication without any attention being required. The perfect state of the piston surface, after being months at work, without any other lubrication, affords ample evidence of the advantage gained by this self-lubrication with a minimum of trouble and expense.

Compression of Charge.

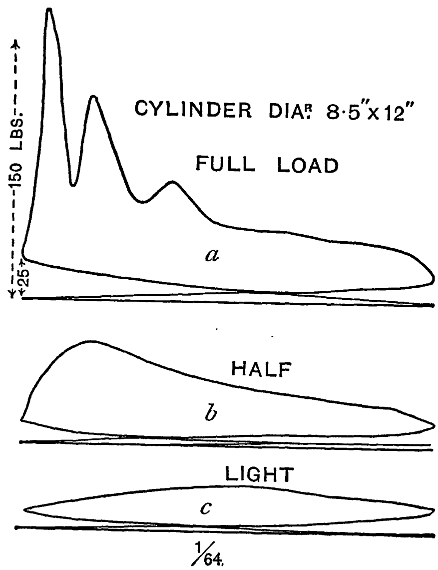
The compression of the charge before ignition only to about 25 or 30 lb. per square inch above atmospheric pressure, is kept low, for fear of much condensation as well as to give smooth running to the engine. In the gas-engine we know that compression of the charge before ignition is essential to high efficiency, and similar considerations lead one to expect the same to hold true for oil-engines. In experiments made on the five horse-power engine, it was thought advisable to try an extra supply of fresh cold air, admitted directly into the end cylinder by a separate pipe, and mix this extra air supply with the previous charge, after leaving the vaporiser. Obviously, very much higher compression than usual, greater power or higher efficiency was obtained; the oil consumption came out ·85 pint, instead of ·93 pint (formerly) per hour per brake horse-power. But then, on the other hand, the temperature of the cylinder became too high for ordinary everyday working, and experience points to a certain limit of temperature that may be reached for economy. For the same reason it is thought advisable to utilise only a small portion of the available heat of the exhaust products, to heat up the fresh incoming charge of sprayed-oil and air. The temperature of the charge on entering the cylinder was 258° to 300° Fahr., in a five horse-power engine, and the temperature of the exhaust gases after leaving the jacket vaporiser was in some instances above 600° Fahr. About 10 per cent. of the total heat of combustion of the oil is thus regenerated in the vaporiser.

Indicator Diagrams.

Fig. 17 shows (nearly half-size) typical samples of indicator diagrams of this engine, for (*a*) full load, (*b*) half load, and (*c*) running light.

The wavy irregularities in line for expansion are perhaps entirely due to the vibration of the indicator spring, which was not quite stiff enough (only $\frac{1}{64}$) to withstand the sudden blow of the explosion. The greatest height represents about 150 lb. per square inch, but the upper part is doubtless due to the vibration, and a stiffer spring would give the mean explosive pressure, about 120 or 130 lb. per square inch. The method of governing is clearly shown. With full load the compression is about 25 lb. per square inch. At half load the governor turns the oil plug, and cuts off part of the oil and air, so that the charge is smaller, and the compression pressure in the same clearance space is reduced by one-half. Consequently, although the charge is ignited at the same moment, the combustion proceeds more slowly, yet with considerable force, and the highest pressure is not reached until the piston has travelled forward a considerable distance. The work done by the gases in the cylinder is made to fit the load on the engine. Finally, when the engine is running light, there is still less oil and air admitted, the compression is diminished, and the explosion is very gradual, giving greatest pressure about mid-stroke.

Fig. 17.



Indicator Diagrams from Priestman Oil-engine.

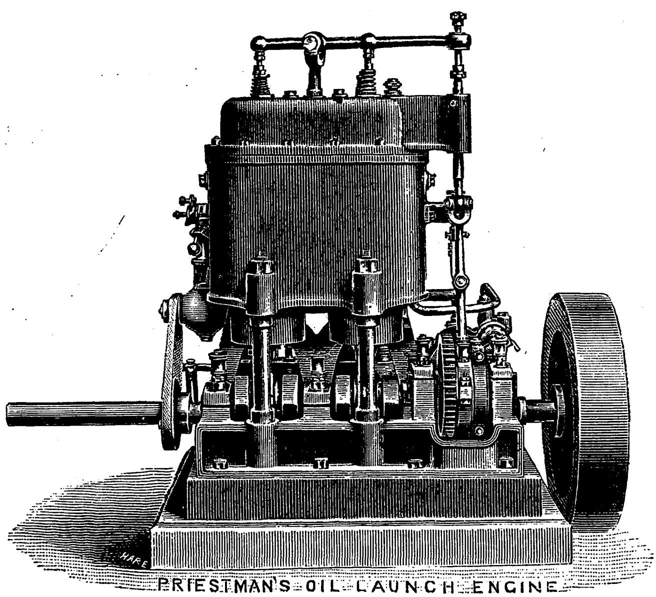
Priestman Engine, Marine Type.

The double-cylinder vertical oil-engine, Fig. 18, is specially designed to run at high speed for marine work, such as driving canal barges and launches. The 5 horse-

power engine has 7-inch cylinders, 7-inch stroke, speed 250 revolutions per minute, and gives one explosion, or working stroke, every revolution of the fly-wheel or heavy disc. The 10 nominal horse-power marine type oil-engine has two cylinders, each 9 inches in diameter by 9 inches stroke, speed 240 revolutions per minute, propelling the boat about nine miles an hour.

The action is similar to horizontal type, the oil being sprayed by compressed air, and heated in a vaporiser by the exhaust gases. The valve gear is very simple. The inlet valves on top of cylinder act automatically. An eccentric on the countershaft, geared to half-speed of crank shaft, drives one vertical eccentric rod, which is timed to open the exhaust valves of both cylinders, against stiff spiral springs. The air-pump which forces oil out of the tank into spray-maker, and the jacket-water circulating pump, are driven by an eccentric on the same countershaft. The spray-maker is of the ordinary type, and the vaporiser is supported from the cylinders. The governor which regulates the supply of oil and air to the spray-maker is driven by belt from crank shaft. The exhaust is carried out at the stern, below water line, or sometimes dis-

FIG. 18.



MARINE TYPE.

charged up a vertical pipe or chimney. Ignition is by the electric spark, and the contact springs can be adjusted to make explosions late when starting. Ordinary burning lamp-oil is used, and the supply for running the boat a week or two can be stored in a tank in the bow, and pumped into the engine oil-tank when required.

The engine runs in one direction only, and a friction clutch is coupled to the main driving shaft for reversing the propeller. A single hand-wheel operates this reversing gear to drive the propeller ahead, astern, or allow the engine to run detached from the propeller. In the latter case, when the boat is stopped for only a short time, the engine is kept running light, controlled by the governor. The boat can be easily handled, and quickly propelled in any direction at will. The engine is well suited for the propulsion of barges and vessels.

CLASS II.—HORNSBY-AKROYD OIL-ENGINE.

The next, and perhaps simplest, type of oil-engine is that in which the oil is injected directly as oil into a hot cartridge, which acts at once as vaporiser and combustion chamber, opening into the engine cylinder. Heavy intermediate oils of specific gravity ·853 can be dealt with as well as ordinary burning oils. One engine of this type is the invention of Mr. H. Akroyd Stuart, of Bletchley, and is

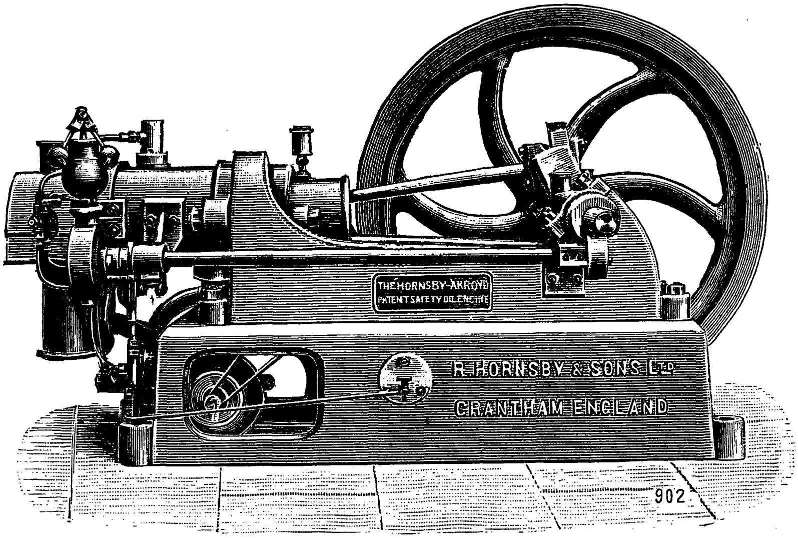
made by Messrs. Hornsby and Sons, Grantham.

The novel feature of this engine is, that the ordinary gear for firing the charge by heated tube, flame, or electric spark, is dispensed with altogether. The heavy oil is injected into the red-hot vaporiser or cartridge, where it is converted into vapour, mixed with air and fired by compression. The Hornsby-Akroyd oil-engine (Fig. 19) is the "Akroyd" engine I described in this room last year, with some modifications of detail. The cycle is the same as in the Otto gas-engine. The essential parts of the engine are shown in longitudinal section and end view in Figs. 20 and 21, pp. 994 and 995.

The vaporiser, or cartridge, C, is of cast-iron, provided with radial ribs to offer a large heating surface to the oil, and communicates directly with the cylinder, A, by the throat or passage shown in Fig. 20. An air-jacket protects the vaporiser from draughts, and regulates its temperature.

The self-acting air inlet valve, D, and the exhaust valve, E, are contained in a box under the cylinder. W is the water jacket around the cylinder. The starting lamp or burner, B L, is filled with oil up to the level of the fan-pipe inlet. The small fan, F, driven by hand, blows air on the top of the oil, and urges a strong clear flame against the vaporiser, and heats it sufficiently in about five minutes.

FIG. 19.



HORNSBY-AKROYD OIL-ENGINE.

The oil-tank is in the foundation, and the charge of oil is forced by means of a pump to the valve-box, V (Fig. 21, p. 995), attached to the vaporiser.

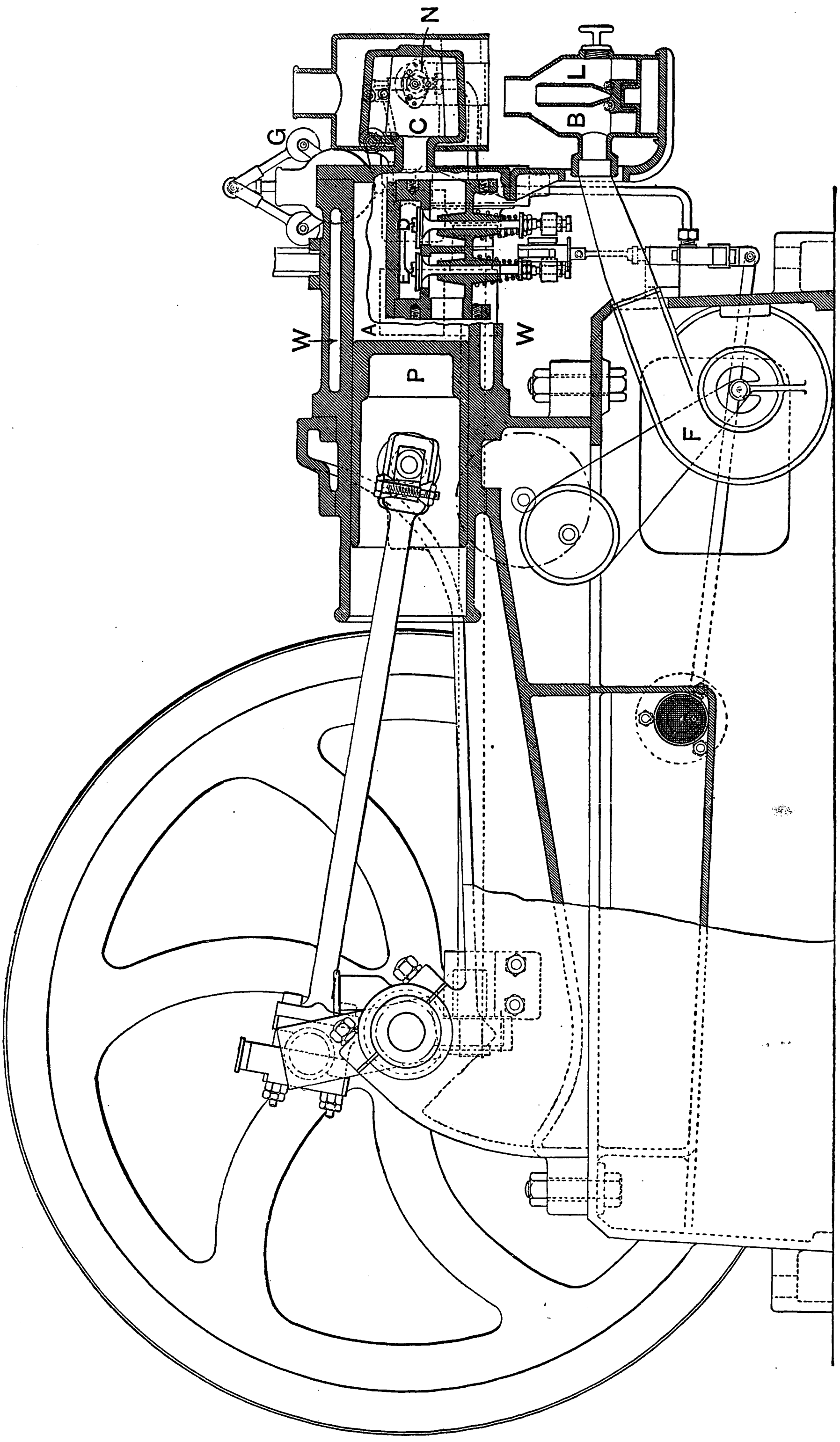
This valve-box contains a horizontal check valve, and a small over-flow or by-pass valve, opened by the governor when the engine is running too fast, allows the surplus oil to flow back to the tank, so that the oil pump is always working, and thus kept in good order.

The valve-box is completely jacketted with water, to keep the oil cool until it enters the vaporiser.

A small Porter governor, G, directly regulates the overflow valve and the inlet valve near the cylinder, and so completely controls and maintains the normal speed at about 200 or 220 revolutions per minute.

The charge of oil is injected by the pump into the vaporiser during the time the air is being drawn in by the piston in its suction stroke. The oil is thus highly heated, and has time to be all thoroughly converted into vapour and mixed with the air during the return stroke, and the explosive mixture so formed is fired by compression inside the hot cartridge. The piston is rapidly driven forward by the burning and expanding gases, giving complete combustion of the charge, so that the exhaust is clean and clear of smoke in ordinary working.

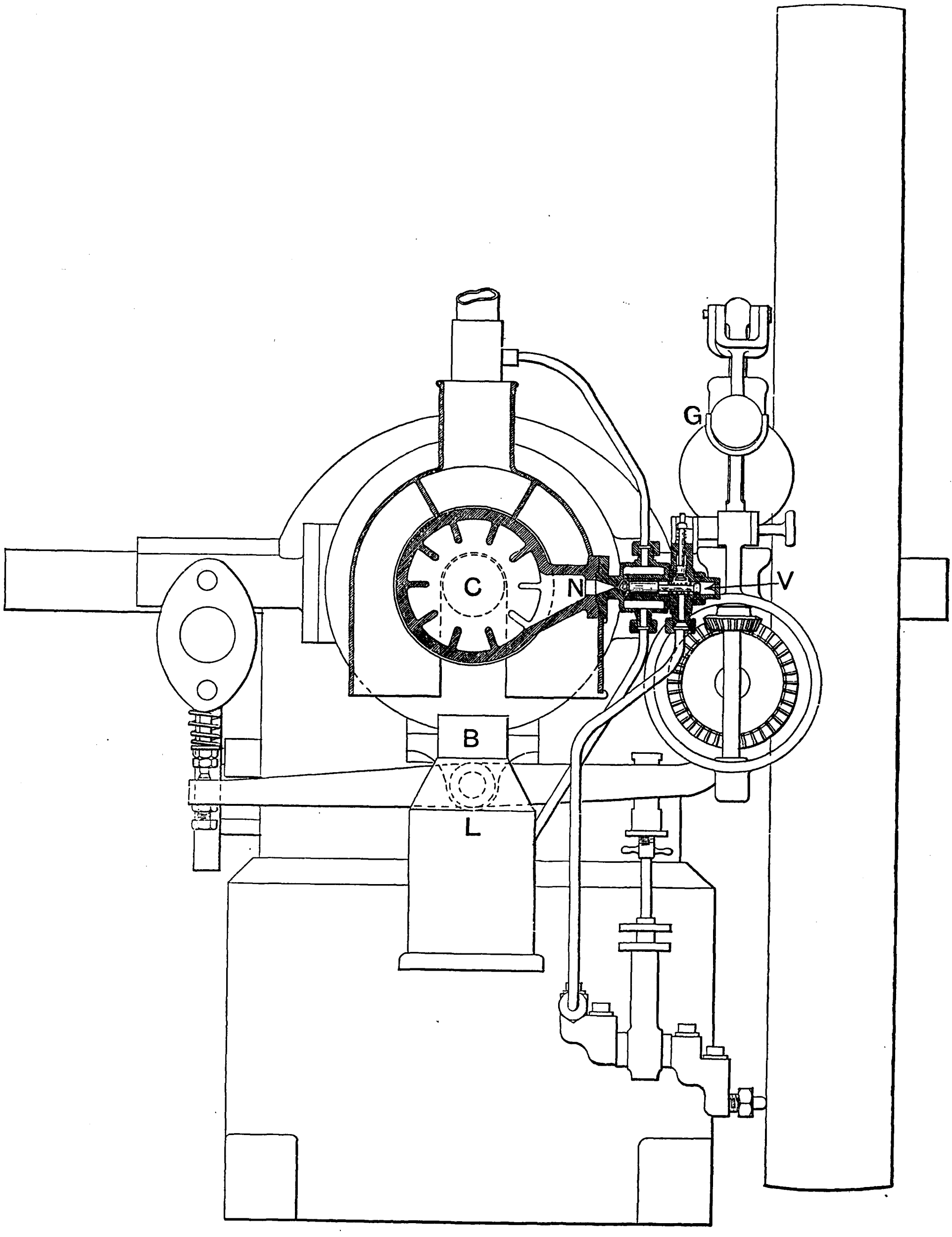
Fig. 20.



Hornsby-Akroyd Oil-engine.—Longitudinal Section.

The indicator diagrams (Fig. 22, *a*, *b*, p. 996), and the full-size card (Fig. 22, *c*) show the high degree of compression which causes the ignition of the charge. The proportion of the volume of vaporiser, including the cartridge and clearance space, to that of the cylinder, in order to ensure rapid and complete combustion, are obtained by experience.

FIG. 21.



HORNSBY-AKROYD OIL-ENGINE.—END VIEW.

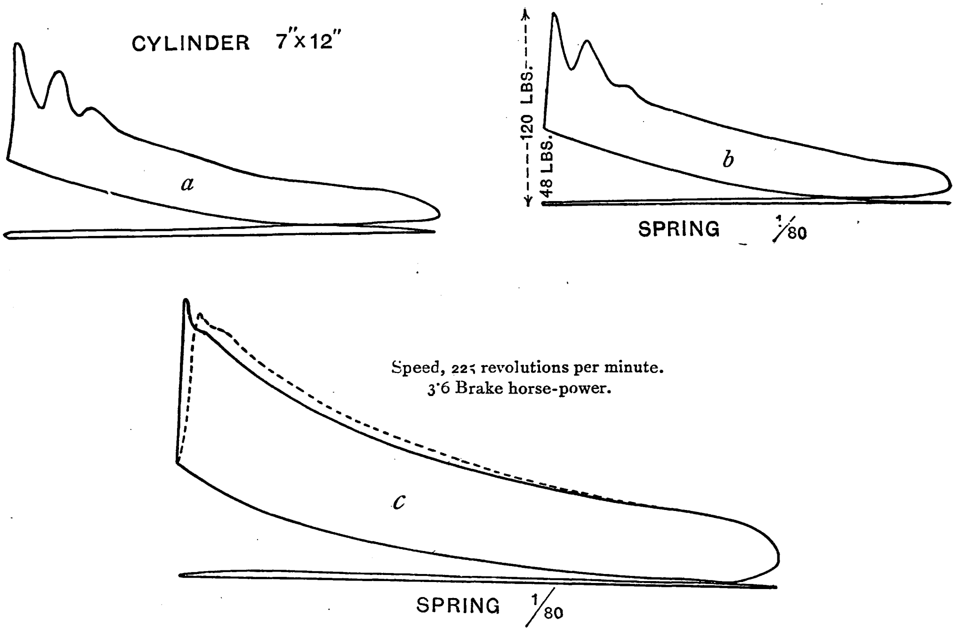
Since there is no condensation of oil, the cylinder requires lubrication, as in ordinary gas-engines.

The cheap intermediate oil used as fuel has a specific gravity of ·853, and flashing point about 225° Fahr. This oil costs 3½d. per gallon in Liverpool, and the average consumption in the engine, under ordinary work-

ing conditions, is about one pint per indicated horse-power per hour, that comes to less than one halfpenny* per hour per horse-power. This cost of fuel for working compares very favourably with that of any other prime motor.

Portable engines of this type are also made with water tank and cooling tubes self-contained.

FIG. 22.



INDICATOR DIAGRAMS—HORNSBY-AKROYD ENGINE.

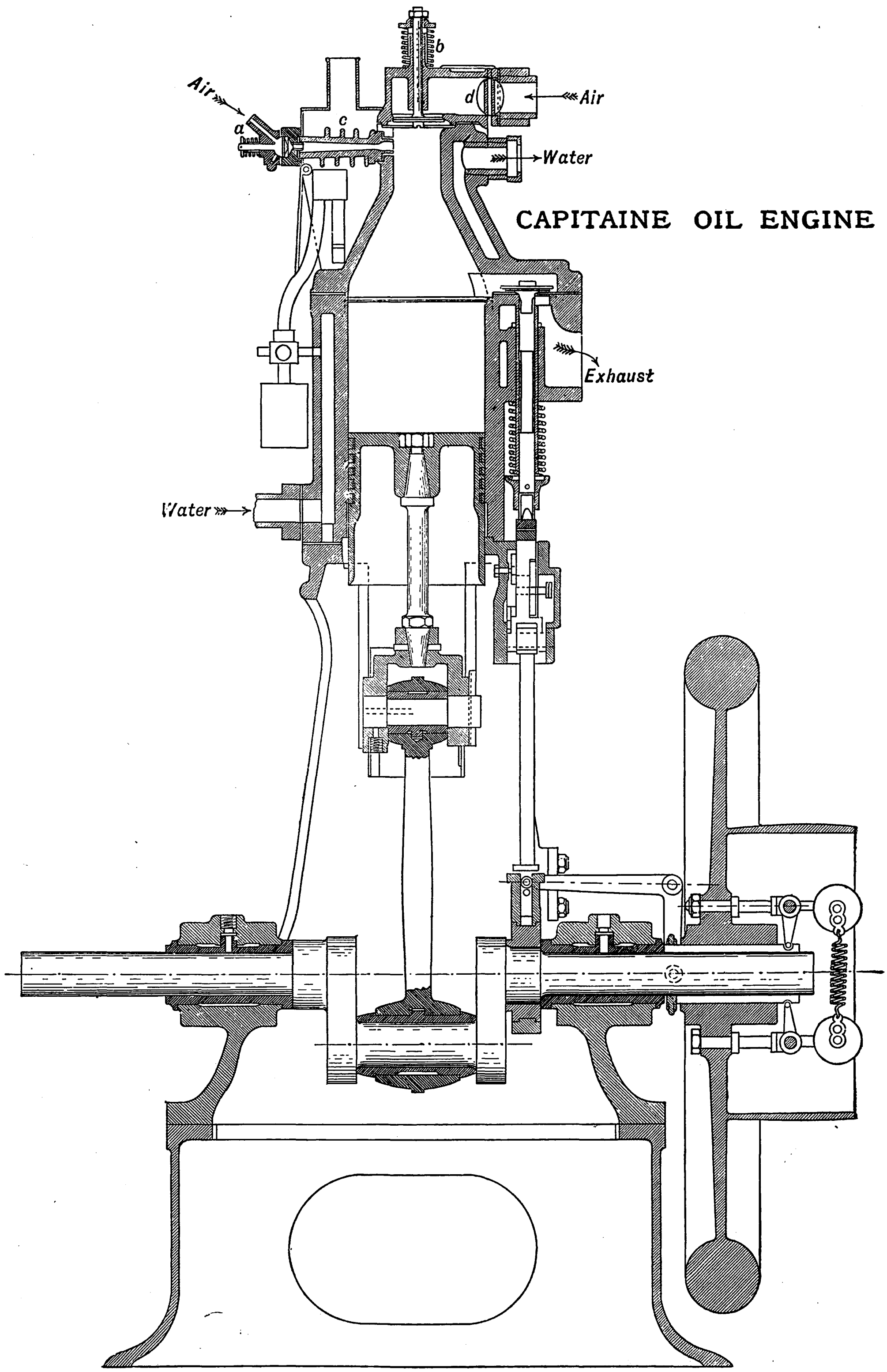
CLASS III.—CAPITAINE OIL-ENGINE.

In the third class of oil engine we find a retort, coil of tubing, or other vaporiser, in which the oil is heated, and converted partially into oil-gas and vapour, by a lamp or other burner. Such a petroleum oil-engine is simply a gas-engine which produces its own oil-gas from the liquid petroleum, overlooking the tarry products, which, sooner or later, make their presence felt, by clogging some of the working parts which need cleaning.

In this case, the vaporiser is really a gas generator.

An example of this type of engine is afforded by the Capitaine Oil-engine, of which we have an actual sample here in the room before us. Fig. 23 (p. 997) shows a sectional elevation of the Capitaine vertical high-speed oil-engine. The truncated piston is connected with a cross-head, which slides in a guide. The top of the cylinder forms the combustion chamber. A small pump supplies oil to the non-return valve passage, *a*, at the top of engine. The motor piston, in its down stroke, opens this valve, sucks the charge of oil, in the form of spray, with a little air, into the vaporiser, *c*. This retort, *c*, is a cast-iron tube flattened egg-shape, with flanges or ribs, to increase heating surface, and is kept at a cherry-red heat by an ingenious lamp, fed by an independent supply of oil from a little tank placed 3 or 5 feet above it. The oil flows by gravitation into this lamp, and ascends to the bent part of the tube, which is heated when starting. Here the oil is vaporised, escapes from below through a small hole, $\frac{1}{100}$th part of an inch in diameter, in the burner cone, and, playing against a piece of incandescent metal, is ignited, and divided in such a way that a most effective blue flame heats the vaporiser retort above the lamp. Consequently, the charge of oil (about ·016 cubic inch in a 4 horse-power engine) sprayed into this retort, kept at a cherry-red heat, is instantaneously decomposed, and converted into a fixed gas and some tarry products. The air enters by the throttle-valve, *d*, and the air-inlet valve, *b*, opened automati-

CAPITAINE OIL ENGINE



cally by suction during downstroke of piston, and the tension of spring on valve-spindle is regulated by hand to admit the exact quantity of air for complete combustion under normal working conditions. In this manner, the air throttle-valve and oil pump may be adjusted, to admit the desired quantity of air and oil, while the engine is in motion. The oil supply is cut off entirely by the engine when governing.

In the engine placed here before you there is no ignition tube; the explosive charge is fired in the vaporiser.

The Capitaine oil-engine also works on the common Beau de Rochas cycle, the same as the Otto gas-engine.

The action of the engine is as follows :—

Before the downstroke of the piston the exhaust valve is closed and the oil pump has supplied the charge of oil to the valve passage, *a*. As the piston moves downward, air is drawn in at *a*, and sprays the charge of oil into the vaporiser, *c*, where it is gasified at cherry-red heat, and is carried forward into the cylinder by the continuous current of incoming air. Air is admitted, during the whole period of the downstroke, both through the top admission valve, *b*, and through the air tube of the spraying valve, *a*. In this way the hydro-carbon gas and vapour will be drawn to the bottom of the cylinder next the piston, and at the end of the down-stroke there will be pure air at the top of the cylinder.

The piston during its upstroke compresses the gas and air into the clearance space and vaporiser, *c*, which is kept red-hot by the outside lamp. As the piston turns the dead-point the compression and contact with the cherry-red vaporiser ignites the charge and the expanding gases drive down the piston.

On the next upstroke the exhaust valve is lifted, the products driven out.

The speed of the small engine of 1 horse-power is 400 revolutions per minute, and that of the 4 horse-power nominal about 300 revolutions per minute.

The mechanical arrangements in this engine are decidedly ingenious. The exhaust valve-spindle and petroleum pump rod are operated by a bell crank lever with three arms, worked by a swinging arm and eccentric rod from the crank-shaft. While the engine is controlled by the governor it does not take in any oil, and all the valves are motionless. The two governor balls, Fig. 23 (p. 997), cast with bell-crank levers, are connected together by a pair of spiral springs and placed within the pulley on the fly-wheel, and rotate with it. When the speed increases, the balls fly apart, move a sliding collar on the crank shaft by means of two rods reaching through the boss of the fly-wheel. The sliding collar moves a bell-crank lever, which pulls down the vertical rod, and its detent on the upper end thus engages an arm on the bell-crank lever, and holds it so as to keep the exhaust valve open and the oil-pump at rest. In fact, while governing, all the valves are quite motionless, no oil is pumped into the cylinder, and the exhaust valve remains open, thus reducing friction, and wear and tear, the piston acting as scavenger, driving all the burnt products into the exhaust box.

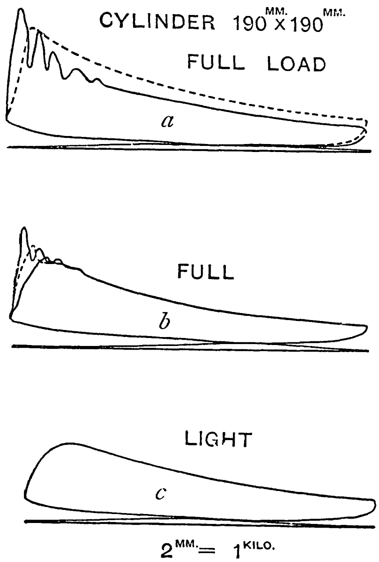
The engine is compact, and occupies little floor space.

However, in my opinion, the method of dealing with the oil is not so satisfactory. The vaporiser, *c*, at a cherry-red heat, converts the oil into real oil-gas, so that there must be tarry products formed which, when burned, leave deposits of soot and retort-carbon in the interior of the engine, clogging the valves. Therefore, inasmuch as cleanliness is essential in every gas and oil-engine, it is absolutely necessary to remove the deposits regularly, at least once a fortnight, or, still better, once a week, for economic working. This is the great trouble in the practical working of such oil-engines that use the oil as oil-gas and not as oil-vapour. Thus the gun-metal tube (inside diameter $\frac{5}{16}$ inch) between the spraying valve, *a*, Fig. 23, and the gas generator, all require cleaning, as there is a deposit of carbon caused by the sudden gasifying of the oil. In the gas generator this is of a soft, sooty nature, but around the tube and the valve it becomes hard. The combustion leaves a deposit of carbon and soot in the compression chamber and exhaust valve. The exhaust box is fitted with a tap-cock, so that the liquid residue, of a light, tarry nature, can be drawn off when necessary.

Fig. 24 (p. 999) shows the indicator diagrams taken from the Capitaine oil-engine, 4 horse-power nominal, with cylinder of diameter 7·5 inches, by 7·5 inches stroke. The results of a trial with this engine, using petroleum of specific gravity ·850, are given as follows:— Compression before ignition, 30 lbs. per square inch; mean effective pressure, 74 lbs. per square inch; speed, 250 revolutions per minute; indicated horse-power, 7·05; brake horse-power, 5·64; consumption per hour per brake horse-power, 0·84 pints of petroleum.

Experience with this engine in practical every-day working, under ordinary conditions and without skilled attention, can alone decide

FIG. 24.



INDICATOR DIAGRAMS, CAPITAINE OIL-ENGINE.

in how far the troubles likely to be caused by the deposits from tarry products, have been overcome.

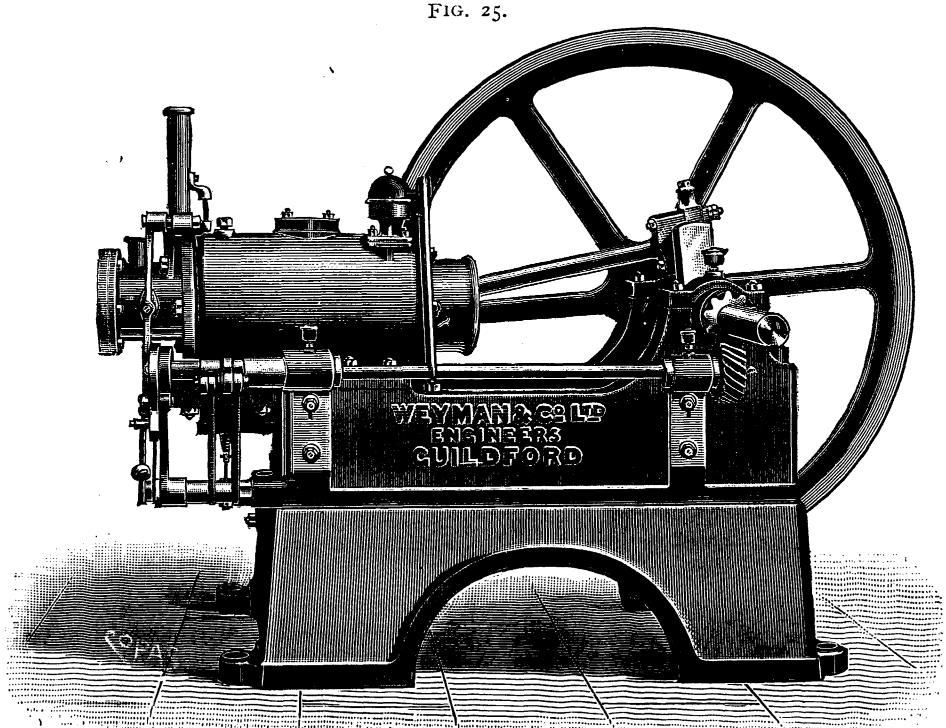
TRUSTY OIL-ENGINE.

As another example of the third class of oil-engine, we may take the Knight engine, as modified by Messrs. Weyman and Co., of Guildford, and now called the Trusty oil-engine (Fig. 25).

In this engine there is no spray-making arrangement whatever. The oil is vaporised or gasified before being admitted into the combustion chamber, where it is mixed with air to make up the explosive charges. The extension at the back of the cylinder (Fig. 25) forms a compression and combustion chamber inside, and the outside annular space or jacket forms the vaporiser, heated by an oil lamp when starting, and afterwards by the explosion of the charges in the cylinder and combustion chamber.

The oil is pumped into the receiver pipe, shown (Fig. 25) above the cylinder, and is allowed to fall, drop by drop, through a sight feed, into the hot jacket around the combustion chamber. Here the oil is converted into vapour, or perhaps a mixture of oil-gas and vapour, depending on the temperature. At the right moment this oil-vapour or gas is drawn into the cylinder through a side valve, and mixed with the right proportion of air. The explosive mixture is fired by a heated

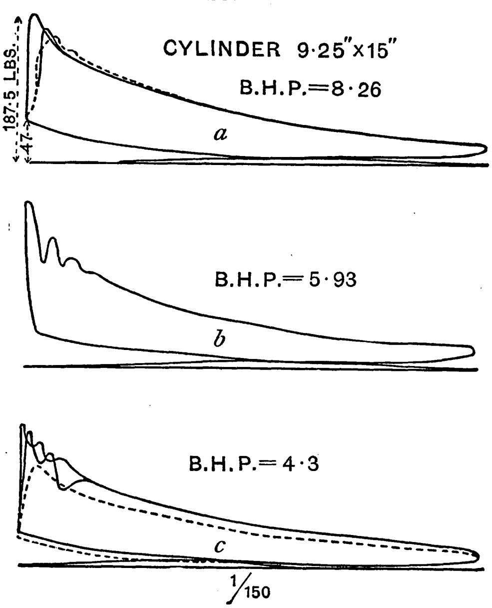
FIG. 25.



TRUSTY OIL-ENGINE.

tube, as in the ordinary gas-engine. A small air pump, on the side of the engine bed, is driven by an eccentric to blow the ignition tube flame. There is a tendency for the oil to become decomposed and to yield the tarry products which form a sooty deposit, depending on the nature of the oils used and the regulation of the vapour temperature. The cover, on the back end of the vaporiser, can be readily removed to clear away deposit, which might cause trouble in practical working.

FIG. 26.



INDICATOR DIAGRAMS TRUSTY OIL-ENGINE.

Fig. 26 shows the indicator diagrams. The rounding of the compression and explosion curves is probably due either to the compression space in the cylinder being too small, or it may be due to premature ignition. It appears that the charge is trying to burn, but cannot until the piston turns the dead point and allows the glowing mass to expand. On the other hand, the dotted diagram Fig 24, *a*, shows late firing of charge.

The normal speed of this engine is 230 revolutions per minute. The consumption of oil, either Broxburn Lighthouse or Royal Daylight, is said to be less than a pint per hour per brake horse power.

OTHER OIL ENGINES.

There are several other petroleum oil-engines—as the Crossley oil-engine and the Robey portable oil-engine—belonging to one or other of the three classes described. We have merely taken representative engines, and must now pass very briefly in review some important points touched upon as common to all.

Considering the attention that is being given to the oil-engine by many leading engineering firms, we may expect rapid advancement and improvement in this class of prime motor, which bids fair to take the place of small steam and gas engines.

MIXING AND PREPARATION OF CHARGE.

Hitherto the most satisfactory mode of dealing with the oil is that adopted in the Priestman engine, namely, spraying the oil, and slightly heating the spray cloud, under ordinary atmospheric pressure, in a large vaporiser, then adding the right proportion of air automatically, to give complete combustion; so that, once the engine is started, there is no exposed flame, and the small condensation of oil in the cylinder serves as a perfect lubricant. Considerable saving is effected by the regenerative principle of utilising heat of exhaust to vaporise incoming charges of oil and air. In some instances, this engine has worked for more than a year without requiring cleaning.

In most other oil-engines there is a difficulty in regulating and maintaining a suitable temperature in the vaporiser, and in mixing the exact proportions of air with different oils, to form an explosive mixture that will burn completely without leaving troublesome deposits in the engine in ordinary working.

Usually, 5 to 15 minutes are required to heat up vaporiser when starting, and in this respect the gas-engine is perhaps somewhat better adapted to intermittent work. At the same time, there are many instances on record of gas-engines requiring a longer time than this to get started.

FIRING OF CHARGE.

In these oil-engines the charge is usually fired either by (1) incandescent metal tube, as in the Trusty and Crossley engines; or (2), by compression into a heated chamber, as in Hornsby-Akroyd, Capitaine, and Robey portable; and (3) by the electric spark, as in the Priestman engine.

Of these methods the incandescent metal tube is most commonly adopted in gas engines.

But we must be careful not to run away with false notions or conclusions by allowing gas-engine experience to bias our judgment too much about firing the charge of oil-vapour and air, because not only is the nature of the

explosive mixtures to be fired very different in the two cases, but also the conditions of working and governing these charges.

In the one case you have to fire gas, and in the other oil-vapour.

In the first method, the metal tube must be heated to incandescence by an oil lamp, and this is not very satisfactory, because there is always the tendency to have a more or less sooty deposit and unpleasant smell indoors, whilst in many positions a naked light is very objectionable, and gives trouble when exposed to wind and weather. The igniting tube may give way when least expected in the middle of a run, and the engine must then be stopped to renew the tube, no matter how critical the moment. The action of a timing valve shortens the life of an ordinary wrought-iron tube to about thirty working hours; special tubes, containing aluminium and other metals as alloys are said to last several months. Wrought-iron tubes on gas-engines rapidly swell and deteriorate, forming crystalline layers of a carbide of iron, which you see by the old broken tubes on the table. As the material in these thick layers is a bad conductor of heat, a stronger flame becomes necessary to heat them through to the inside, and ignition becomes uncertain until at last the tube bursts, and, if the engine is not stopped, may cause serious injury. Moreover, there is further trouble with the carbon deposit inside metal tubes used on oil-engines, unless the temperature of the whole tube is very high. Porcelain tubes have been tried on the Capitaine, but experience shows that these are open to the objection which affects glass and earthenware material, viz., that when intensely heated and subjected to sudden cooling action, they shiver in pieces, as when cold water is thrown on hot glass. In the Capitaine engine, after the night's rest, there is aqueous vapour condensed in cylinder and porcelain tube, which prepares it to be broken when suddenly heated at starting.

Again, the heated tube cannot be raised to such a high temperature as the electric spark, and, therefore, cannot give so powerful and certain an ignition as we obtain in the Priestman engine.

Ignition by the electric spark is even recommended for gas engines by Monsieur Edward Delamare-Deboutteville, of Rouen, in his interesting and instructive paper*, read before the Institution of Mechanical Engineers in Paris, at the International Exposition of 1889. He says:—"During a course of experiments on all the systems of ignition known, the paramount importance of a thoroughly good ignition has been conclusively proved. For safe working it is indispensable to have a perfectly certain ignition; .... and as a powerful ignition is a condition of immense importance, this condition is only fulfilled by the electric spark. All the methods of ignition by flame have proved inferior to it in this respect, including the superheating of a platinum wire by a flame, and the expedient of raising a *thin* tube to a red heat."

Moreover, the charge can be fired by the electric spark at any desired part of the stroke, which is a great desideratum, with perfect precision and greatest rapidity, several times in a second.

Throughout long runs in a Priestman engine doing duty with the ordinary kerosene oils, there is no deposit on the porcelain insulator. Of course it is easy to raise a deposit if you wish, but with ordinary care this may be almost entirely avoided, although with the heavy oils there is at times a slight deposit. So perfect is the combustion in the engine cylinder, that if a plug be covered with soot or carbon, and fixed in the engine, it will be cleaned in the act of running.

The battery only wants renewal, the prepared charge consisting of 8 ozs. bichromate of potash, finely powdered and dissolved in 80 ozs. of water, and 6 ozs. of fluid sulphuric acid (H_2SO_4) is added to the solution in which the zinc plates are placed. This charge should last 30 working hours, and when the spark becomes weak, an additional 3 ozs. of sulphuric acid revives the battery and prolongs its life by 10 or 20 hours more.

Experiments made to find the life of one of these bichromate cells showed that battery life, with continuous spark, was 76 hours 55 minutes; whereas with contact make and brake arrangement, as in Priestman engine giving intermittent spark, the cell lasted 126 hours 40 minutes; thus proving that the intermittent spark is much easier on the battery than a continuous discharge.

Cost of Ignition.

Further, the cost of working this electric igniter is small, and compares favourably with that of the heated tube. Taking the average working life of the battery in the Priestman engine to be, say, 40 hours, buying

* See paper, "Gas Engines," Proc. Inst. Mech. Engineers, p. 500; also *Engineering*, August, 2, 1889.

the chemicals at wholesale prices, and making them up according to the above recipe, the *cost per day of ten working hours*, including zinc, would be about 1d. or 1¼d. Suppose the user gets his materials at local rates, allowing the retailer a profit of 50 per cent. over the wholesale prices, the cost of the battery would not be more than 1½d. to 1¾d. a day, no matter what the power of the engine.

Let us see how this compares with the case of the heated tube ignition. We shall take the figures obtained by Mr. W. Worby Beaumont during a trial of the Weyman "Trusty" oil-engine last December. The igniting tube was heated by a flame from oil lamp, which used 0·58 lb. of oil in 3½ hours of working; that is, at the rate of 1·66 lb. during ten hours, or one day. The Broxbourne Lighthouse oil used was of specific gravity 0·810, and the price 6·5d. per gallon of 8·1 lb. Consequently the 1·66 lb. of oil used cost 1⅓d. A new wrot-iron tube costs 2d., and lasts about 30 or 40 hours, so that the cost of renewal is from a ½d. to ⅔d. per day of ten hours; total cost comes out 1⅚ to 2d. a day.

Hitherto, we have had more to do with heated tube ignition in gas-engine work, and the gas consumption for this purpose alone in the Atkinson engine varies from 4·5 to 5 cubic feet per hour. If the price of gas be 2s. 6d. a 1,000 cubic feet, the gas bill for heating the tube alone comes to 1⅓d. or 1½d. per day. In some gas-engines wrot-iron tubes last about 30 hours, and at 2d. a piece, costs ⅔d. a day. So that the total cost in this case is also about 2d. a day of 10 hours.

There appears, therefore, no practical gain in pence by using gas to heat the ignition tube, although it is much cleaner and more convenient than oil when the engine uses gas.

Furthermore, the electric ignition has several important advantages in oil-engines. The plug, when screwed into the cylinder, has the platinum points inside the cylinder, so that the spark works equally well out in the open air exposed to wind and weather. There is no naked flame, and therefore it may be used in a coal mine. The contacts can be adjusted to have the spark at the desired moment. If the spark becomes weak, a little more sulphuric acid added to the battery enables you to continue running the engine, and you are not obliged to stop for renewal, as in the case of the heated tube bursting. The charge or dose of chemicals for the battery is made up and supplied by the makers of the engine, and any ordinary labourer can add the necessary water.

Methods of Governing.

There are two methods of regulating the speed for varying load in oil-engines, by the governor, either (1) *entirely cutting off the oil supply to the cylinder* for one or more working strokes, when the speed is too high or (2) *varying admission or partial cut-off*; that is to say, varying the amount of oil and air-supply to engine, thus forming a more or less powerful explosive mixture, according as the engine speed is slower or faster than the normal.

1st. In most gas-engines the simplest and most effective governor completely cuts off the supply of gas, and thus reduces the number of explosions, when the speed is too fast, until the normal speed is reached, and then the regular quantity of gas is again admitted. In engines of the Otto cycle, with only one explosion in two revolutions, one miss-fire means that the piston does not receive an impulse during at least 3½ revolutions, and this renders it difficult to maintain uniform speed, especially when the load is suddenly increased soon after the charge is cut off. In this way the speed is seriously reduced. Moreover, the air has, in the meantime, swept out the residual products, and the cylinder is slightly cooled; so that, when gas is again admitted, the mixture being undiluted, gives a more powerful explosion than usual, so that the speed changes rapidly.

The same holds true for oil-engines.

In order to ensure greater regularity of running, and overcome slight fluctuations in load, larger fly-wheels are used, and the engines run at much higher speeds than heretofore.

2nd. The second method has not been generally adopted in gas-engines. It is found that, with either too little or too much gas, the weaker and stronger charges formed are likely to be non-explosive; consequently, there is no explosion, and the charge is lost or passed into the exhaust, where it remains until the hot products from the next explosion ignite the unburnt gases in the exhaust pipe, giving explosions with unpleasant cracks or reports. The gas is thus expended to no useful purpose, as these explosions in the exhaust pipe merely tend to annoy neighbours or frighten sparrows.

In the case of oil-engines it is different.

For instance, we have already seen in the

Priestman spray-maker that the amount of air is adjusted by the wing throttle valve to suit the oil passing through the oil-plug, and that the governor adjusts them both simultaneously by turning the spindle or oil-plug, so as always to form an explosive mixture, no matter whether the charge is a weak or strong one.

The indicator diagrams, Fig. 17 (p. 988) show clearly the effects of this mode of governing on the behaviour of the charge in the cylinder. When the speed is too fast, a weak charge is formed, which gives a slower and later combustion in the cylinder, the mean effective pressure on the piston being thus reduced. Moreover, since the amount of oil and air entering the cylinder is reduced, the compression is not so high, and, therefore, the combustion is slower and not so perfect. The impulse every revolution gives steady smooth running, with gradual and not spasmodic variations in speed.

RESULTS OF PRIESTMAN ENGINE TRIALS.

In order to obtain practical results from different oils working in the same engine, I made a series of trials of a 5 horse-power Priestman horizontal engine, of the newest design, with cylinder $8\frac{1}{2}$ inches diameter and 12 inches stroke. The volume of clearance space in the cylinder 370 cubic inches or 0·2141 cubic foot. An ordinary-rope brake was on the flywheel of effective diameter 4·64 feet.

The typical samples of ordinary burning oils tried were the Broxbourne Lighthouse oil, Royal Daylight, Russian Ordinary or Russolene, and Russian Lustre, tested as in Table I., p. 964, and analysed with particulars given in Table IV.

TABLE IV.—OILS USED IN TRIALS.

Brand of Oil.	Specific gravity at 60° Fahr.	Flashing Point, Abel Test. Fahr.	Chemical Analyses.		Wholesale price per gallon, delivered naked in London and Liverpool.
			Carbon in 1 lb. Oil.	Hydrogen in 1 lb. Oil.	
Lighthouse	0·810	152°	0·8601	0·1390	$4\frac{7}{8}$d.
Daylight	0·796	76°	0·8462	0·1486	$4\frac{1}{2}$d.
Russolene	0·824	82°	0·8588	0·1407	$3\frac{5}{8}$d.
Lustre	0·825	—	0·8600	0·1395	$3\frac{1}{4}$d.

After preliminary trials, the engine was run for several hours with full load, half load, and light. Table V. gives some of the results obtained with various oils.

The indicator diagrams, here on the table, and the set shown in Fig. 17 (p. 988) are average samples of those taken. The vacuum at end of suction stroke was about 5 lb. per square inch below atmospheric pressure, and about 7 lb. per square inch when running light. The pressure at end of compression stroke, from 25 to 28 lb. per square inch for full load, was reduced when governing to 12 lb. per square inch for half load, and then the highest explosion pressure, Table V. (p. 1004) was only reached in some cases about one-quarter stroke owing to the slow gradual combustion.

Broxbourne Lighthouse oil gives decidedly the best results, both as regards power developed on the brake and shown by the indicator diagram; but its present high price tends to prohibit its general use. It is a safe oil, homogeneous in composition, and can be vaporised within a limited range of temperature below 300° C., as shown by fractional distillation curves, p. 967. Consequently the more rapid and complete is its combustion in the engine cylinder, giving a much higher pressure and better diagram than any of the other oils tried.

As regards the

CONDITIONS FOR ECONOMIC WORKING,

it would appear that the compression chamber or clearance space in the cylinder should be somewhat smaller in the case of Lighthouse and Russian Lustre than for Russolene and Royal Daylight oil. The clearance is reduced by simply fixing a plate on the end of the piston.

TABLE V.—Results of Engine Trials with different Oils.

		Brand of Oil.							
		Russolene.		Lighthouse.		Royal Daylight.		Russian Lustre.	
	Date of trial	December 11th, 1891		February 18th, 1892.		February 16th, 1892.		February 17th, 1892.	
		Full Load.	Half Load.	Full Load.	Half Load.	Full Load.	Half Load.	Full Load.	Half Load.
	Duration of trial (hours)	3	3	2	2	2	2	2	2
	Revolutions per minute	204	212	212	218	212·4	211	211	212
Power.	Mean effective pressure in cylinder (in lb. per square inch)	43·39	—	50·4	—	47·36	—	51·2	—
Power.	Effective brake load (in lbs.)	75·5	38	85·5	43·5	75·5	40	75·5	40
Power.	Brake horse power	6·76	3 54	7·5	3 9	7·05	3·7	6·9	3·7
Oil used.	Oil consumed (pints, ounces)	19 0	13 13	14 0	9 5	13 0	10 0	13 4	9·5 0
Oil used.	Oil used per brake horse-power per hour (pints)	0·93	1 28	0 93	1 2	·9	1 35	0·96	1·28
Oil used.	,, ,, ,, ,, (lbs.)	0·958	1·32	0·94	1·216	·912	1 37	0·989	1·32
Oil used.	Wholesale price of oil per gallon (d.)	$3\frac{5}{8}$	—	$4\frac{7}{8}$	—	$4\frac{1}{2}$	—	$3\frac{1}{4}$	—
Efficiency.	Cost per brake horse-power per hour (d.)	·4	·59	·57	·735	·5	·76	·39	·52
Efficiency.	Heat value of oil	..	..	19,000 British thermal units approximately.				..	..
Efficiency.	Heat converted into work at brake efficiency (per cent.)	14	10·5	14·4	11·16	14·9	10	13 72	9·18
Efficiency.	Heat converted into work in cylinder efficiency (per cent.)	..	..	12 to 15 per cent. more than at Brake.				..	..
Temperatures.	Temperature of water entering jacket (Fahr.)	47°	47°	43°	52°	39·4°	39°	39°	40°
Temperatures.	,, ,, leaving ,, ,,	126°	108°	135°	128°	127°	118°	130°	122°
Temperatures.	Heat carried away (per-centage of total supplied)	..	..	..	40 to 50 per cent.		..	..	..
Temperatures.	Temperature of vapour entering cylinder (Fahr.)	258°	270°	258°	267°	270°	276°	282°	300°
Temperatures.	,, ,, exhaust leaving vaporiser (Fahr.)	590 to 600° and upwards.	480°	—	—	above 600°	—	—	—
Pressures.	Air pressure in oil tank (lb. per square inch)	8·5	9·5	12	12	10·4	11	10	10
Pressures.	*Pressure from Indicator Diagrams.*								
Pressures.	Compression, before ignition (lb. per square inch)	28	12	30	12	25	12	25	10
Pressures.	Explosion pressure	120	50	140	50	120	50	120	49

Take, for instance, Daylight oil in the same engine having the clearance reduced from 0·2141 cubic foot to 0·2101 cubic foot. This change increases the compression of the charge before ignition from 25 to 35 lb. per square inch, and the mean effective pressure from 47 to 53 lb. per square inch, thus increasing the power developed by the engine, running at the same speed, from 7·05 to 7·72 brake horse-power.

As a matter of fact, for any particular oil experience alone must decide the degree of compression before ignition that gives best results as regards power, efficiency, and economy, consistent with durability of the engine. In several sets of trials made with another oil-engine of the Priestman type, it was found that Lighthouse oil also gave out the greatest power. Again, experience shows that these ordinary lamp oils differ slightly in their order of merit in a 5 horse-power engine as compared with the figures obtained in a 1 horse-power engine. That is to say, the efficiencies of different oil vary somewhat with the size, and depending upon the relative cooling surfaces of these engines. Therefore, the dimensions of engines have to be taken into account, when determining the most suitable kind of oil to be used therein. At the same time, for some of the best oils, the difference is not very great. Thus, "Royal Daylight" works very well in small engines, whereas, in larger engines, "Russian Lustre," which is a cheap oil, can be used to advantage; and, doubtless, the price of an oil must stand as an important factor in the way of its adoption for use in this class of prime movers.

The efficiency might be pushed much further, but practical considerations, and the conditions of everyday work, render it absolutely necessary, for steady constant running, that the temperature of the cylinder must be kept down, to allow of proper lubrication. After all, the tests (Table V.) show that 14 or 15 per cent. of the total heat of combustion of the oil is turned to useful mechanical energy on the brake; that is, a consumption of less than 1 lb. of oil, costing about ½d. per hour per brake horse-power.

These tests and figures abundantly prove that we have now, at least, an oil-engine which is thoroughly reliable and steady, having already done good work, without special care or attention, for a year or two, and using, in a most economical manner, the safe common burning oil that can be obtained in every country village.

There are, unquestionably, many positions in which the oil-engine will prove of great practical utility, and, for small powers—at least up to 20 h.p.—take the place of both gas and steam-engines.

Miscellaneous.

PATENT FEES.

The reduced scale of patent taxation—which the industrial community owes to the late Chancellor of the Exchequer and the late President of the Board of Trade—came into operation on October 1. In order to understand and appreciate the nature of the boon which Mr. Goschen and Sir Michael Hicks Beach have conferred upon inventors, it is necessary to glance back at the history of patent taxation in this country. Previous to the year 1852, Letters Patent, issued under the Great Seal of England, extended to England, Wales, and Berwick-on-Tweed alone, and cost in stamps and fees nearly £150. If the patentee desired to have his invention protected in Scotland and Ireland he was obliged to take out a separate grant for each of these countries, at a cost of about £85 in the former case, and £150 in the latter. The cost of taking out and maintaining for the full term of fourteen years allowed by the Statute of Monopolies a patent which was operative in every part of the United Kingdom, fell little short, therefore, of £400; and this heavy tax had, moreover, to be paid by the patentee practically at the time when his patent was issued. In 1852, however, the Legislature, acting upon the report of a Parliamentary Committee, before which the most distinguished experts of the day had given evidence, inaugurated an important departure from the old *régime*. The Patent-law Amendment Act of 1852 extended the scope of Letters Patent to the United Kingdom, the Isle of Man, and the Channel Islands; reduced the patent-tax from about £400 to £175; and enabled a patentee to pay the heaviest part of it in two instalments of £50 and £100 before the expiration of the third and seventh years respectively of the patent term.

The full significance of this change in the policy of the State towards inventors is not, perhaps, superficially apparent. It was not merely that the patent fees were cut down to less than half their former amount. The patentee was now enabled, by the comparatively trivial payment of £25, to have his invention protected throughout every part of the United Kingdom for three years; on payment of the first renewal fee of £50 before the expiration of the third year of the term, the protection was extended for another four years. The practical effect of the new statute, therefore, was to give him the benefit of

a "sliding scale of duration," such as we find in many continental patent systems. But this was not all. Under the old law a patentee had been obliged to pay practically the whole tax at the commencement of the term, not only before his invention had begun to be a source of profit, but just at the very time when he had to incur the most serious outlay in order to establish it and commend it to the public. The postponement of the heavier payments till the middle and latter end of the term relieved him from this grave and often ruinous obligation, and enabled him to determine whether the continuance of his patent was advisable. In 1884, the Board of Trade—of which Mr. Chamberlain was then President--introduced other and not less important reforms in the scale of patent taxation. In the preceding year, the Legislature had abolished the numerous minute and complicated stages through which, under the Act of 1852, a patent had to pass before it received the impression of the Great Seal. It was felt that the preliminary fee of £25 was no longer justifiable, now that the procedure in connection with the grant of Letters Patent had been simplified, and it was, accordingly reduced to £4 in the first rules made by the Board of Trade under the Patents Act of 1883. The renewal fees of £50 and £100 were not reduced, but the time for paying them was extended from the third and seventh to the fourth and eighth years respectively of the patent term, and an alternative system of payment by annual instalments, commencing at the fourth year from the date of the patent, and varying in amount from £10 to £20, was established.

Mr. Goschen's skilful financial policy, the increasing volume of the patent business of the country, and the careful husbandry of the resources of the Patent-office, for which the Board of Trade has in recent years been so often, and so unjustly, censured, enabled the late Government to signalise its departure from office by the promulgation of the Patents Rules, 1892, which came into force on Saturday last, and make material reduction in the scale of patent taxation. The preliminary fees of £4, which protect an invention for four years, are still payable, and so long as the law permits a man to patent practically anything that he chooses, we fail to see how they can, with any advantage to the public, be very much reduced. But the renewal fees are diminished in the most wholesale and generous way. The instalments of £50 and £100 are abolished, and the system of annual payments, which was optional under the old rules, is now to be the recognised mode of taking out a certificate of renewal, although the patentee may, of course, pay the whole or any portion of the aggregate of the prescribed annual fees in advance. In lieu of the fee of £10, which was formerly payable before the expiration of the fourth, fifth, sixth, and seventh years of the term, fees of £5, £6, £7, and £8 are now prescribed. Fees of £9 and £10 replace the old fee of £15, which had to be paid before the expiration of the eighth and ninth years from the date of the patent, while fees of £11, £12, £13, and £14 are substituted for the fixed fee of £20, which has hitherto been payable between the tenth and thirteenth years of the grant. The entire cost of obtaining a patent and keeping it up for fourteen years has thus been reduced from £154 to £99. The fees of £3, £7, and £10, heretofore payable for one, two, or three months' extension of the time for the settlement of the annual instalments, have also been diminished to £1, £3, and £5 respectively. In the not distant future—when the reconstruction and reorganisation of the Patent-office have been completed, and the experiment, now commencing, has been justified by results—it may be possible for the Board of Trade to recommend still more radical changes in the scale of patent taxation. In the meantime the country will receive the valuable concessions which the new patent rules contain with a grateful recollection and recognition both of the spirit that prompted them, and of the skill that rendered them possible.—*Standard*:

Obituary.

SURGEON-GENERAL BELLEW, C.S.I.—Dr. Henry Walter Bellew, the eminent Oriental scholar, who died on 26th July last, read a paper on the "Injurious Effect of Canal Irrigation on the Health of the Population of the Punjab, and their remedy," before the Indian Section on May 4, 1888, and shortly afterwards was elected a member of the Society. Dr. Bellew was the son of Brevet-Major H. W. Bellew, killed during the retreat from Cabul in January, 1842. After some months experience of the Scutari hospital, and of sick and wounded troops on board a transport during the Crimean war, he sailed to Calcutta in 1856, and on his arrival he was placed in charge of the Corps of Guides on the Peshâwar frontier. He was associated with several important missions, and in 1869 he was appointed interpreter in the suite of the Amir Sher Ali Khan, when his highness attended the Umballa Durbar. In 1877, Dr. Bellew was appointed Sanitary Commissioner, Punjab. He retired in 1886, and settled in England. He was distinguished as a linguist, and published a dictionary and grammar of the Pushtu langauge. Amongst his other works may be mentioned—"From the Indus to the Tigris," "Kashmir and Kashgar," "Afghanistan and the Afghans," "The Races of Afghanistan," and a "History of Cholera in India, from 1862 to 1882."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

UNION OF INSTITUTIONS.

The following institution has been received into union since the last announcement:—

Manchester Athenæum, Manchester.

Chicago Exhibition, 1893.

PHOTOGRAPHIC COMMITTEE.

A meeting of the Photographic Committee was held on Wednesday, 26th inst. Present: Francis Cobb (in the chair), George Davison, James Dredge, Colonel J. Gale, and Sir Henry Trueman Wood, secretary to the Royal Commission.

DEDICATION CEREMONIES.

The following account of the opening ceremonies, on the 21st inst., is taken from Reuter's special report:—

By a series of imposing ceremonies, the great "park of palaces," in which the World's Fair is to be held next year, was formally dedicated to-day. The principal ceremonial took place in the Manufactures and Liberal Arts Building, in the presence of 100,000 spectators. This building is the largest structure that has ever been erected, and the assemblage which it accommodated to-day is the largest which has ever been brought together beneath a single roof. The audience, it may further be said, contained the most numerous and most representative gathering of distinguished Americans that has ever been seen. At nine o'clock this morning, most of those who intended to take part in the great procession which preceded the indoor ceremony assembled in the Auditorium, and proceeded in carriages in processional order to the World's Fair grounds.

The procession was formed near the Auditorium, in Michigan Avenue. It was escorted by cavalry and light artillery, and consisted of a long array of officials, members of the Government, of the Senate, of the House of Representatives, the Diplomatic Corps, the Judges, representatives of the army and navy, the Governors of the States and Territories of the United States, and the City Council of Chicago. A specially-interesting feature in the gathering was the presence of women, representing each of the 13 original States. The Board of Lady Managers, headed by their President, were also present. Vice-President Morton attended in the absence of President Harrison, due to the illness of his wife; and, among other prominent men present, were ex-President Hayes and Cardinal Gibbons. The Commissioners of foreign nations at the Fair filled 15 carriages, and the foreign Consuls five. Thirty more carriages were occupied by the other Columbian Commissioners. The architects of the Fair buildings were also present.

Passing through the streets to Washington-park the procession formed in parallel lines on the west side of the parade grounds. On the opposite side the National and State troops had meanwhile been drawn up in brigades. The whole formed a brilliant array. The troops presented arms and a Presidential salute was fired by a battery of artillery. A national salute was also fired as the long line of carriages filed into the Show grounds. The troops on parade, including infantry, marines, and militia, numbered over 15,000. They came from Ohio, Indiana, Missouri, Michigan, Wisconsin, and Illinois.

It was nearly two o'clock when the band of music announced to the multitude in the vast building that the procession had arrived. The cavalry escort at the head of the column rode in full marching order directly through the portals into one of the wings flanking the structure on each side. They then took up their places with the other regular troops beneath the side gallery. The staffs of the State Governors and other military men of rank took their seats on the grand stand, their variegated uniforms making up a brilliant mass of colour. A few minutes later a great cheer went up as the vanguard of the officials and guests appeared upon the platform. At their head was Mr. Lambert Tree, formerly American Minister at St. Petersburg, acting as escort to the foreign Diplomatic Body. Baron di Fava, the Italian Minister, Doyen of the Corps Diplo-

matique at Washington, leaned on Mr. Lambert Tree's arm.

The chorus, at a given signal, struck up a "Columbian March," written for the occasion by Professor Paine.

After the singing of the "Columbian March," prayer was offered by Bishop Charles H. Fowler, of California.

An introductory address was then read by the Director-General, as master of ceremonies. It was followed by an address of welcome by by Mr. Washburne, Mayor of Chicago.

A dedicatory ode, by Miss Harriet F. Monroe, of Chicago, was then partly read and partly sung. The stanzas selected for musical rendering were given with magnificent effect by a chorus of 5,000 voices.

The master artists of the Exhibition were next presented to the President of the Exhibition, and were each handed commemorative medals. The chorus having sung Haydn's "The Heavens are telling," the buildings were formally handed over for dedication. Vice-President Morton having performed this ceremony, and the full chorus and orchestra having rendered "The Star-spangled Banner" and "Hail Columbia," Mr. Chauncey Depew delivered the Columbian oration.

More music followed, and prayer having been offered by the Rev. John Ireland, Archbishop of St. Paul, the Benediction was pronounced by the Rev. Mr. Maccook, of Philadelphia.

The day was observed as a general holiday in almost every part of the country, and in many other cities the occasion was celebrated by banquets and other festivities.

Mr. Alfred Carpmael and Mr. John Biddulph Martin, Members of the Royal Commission, and Colonel Grover, R.E., attended the ceremonies, as representatives of the British Section.

Proceedings of the Society.

CANTOR LECTURES.

USES OF PETROLEUM IN PRIME MOVERS.

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Assoc. M.Inst. C.E., University College, Nottingham.

Lecture III.—Delivered March 14, 1892.

Oil-gas Producers.

In our last lecture we considered some of the practical and successful solutions of the problem—how to use common refined petroleum oils, instead of gas, as fuel in the cylinder of the internal combustion engine. One difficulty is to convert all the oil into vapour, when preparing the charges, without forming oil-gas, because the tarry products given off with the gas at high temperatures cause trouble in practical working. Here the vaporiser tends to become a gas generator as the temperature is increased and the oil heated alone.

The idea is to have the total heat of combustion of the oil vapour available, and, at the same time, to take advantage of the high efficiency of the internal combustion engine. Several engines even utilise some of the heat of the exhaust gases from the previous explosion to vaporise the oil for the incoming charge.

Notwithstanding these laudable attempts in the right direction, it is found that, if the oil be in the state of liquid or vapour, it is difficult to obtain complete combustion except with a seriously excessive amount of air over that required according to the chemical analysis of the oil.

From the above, it follows that in large petroleum oil-engines the ordinary vaporisers are somewhat troublesome to work with, although they offer special facilities for the application of the Stirling regenerative principle to utilise some of the waste heat of the exhaust.

It appears then that, for large engines, another practical plan is to convert the cheap and heavy hydro-carbon oils into true and fairly pure gas, by means of a simple oil-gas producer. This oil-gas, when washed and cooled, can be used with economy in the ordinary gas-engine, which may thus give motive power in a country district where there is no coal-gas supply.

Loss in Gas-making.

Of course some of the heat of combustion is lost in the operation of preparing the gas; still, in spite of this loss, a decided saving in fuel may be effected by the *combination of oil-gas producer with gas-engine*, instead of the *steam boiler and steam engine*, in places where intermittent work is required, suitable oil cheap and plentiful, and where the price of coal is high.

On the other hand, more heat may be produced by the direct combustion of the oil than by first converting the oil into a gas before

using it as fuel. This is obvious when we bear in mind that it is impossible to create energy by any round-about process, however mysterious; and that there must necessarily be some loss in every process of gasifying fuel.

Take for instance 1 lb. of coal of calorific value 14,200 British thermal units, that is 1 lb. of coal which gives out by complete combustion heat energy equivalent to 14,200 × 772 or in round numbers nearly 11,000,000 foot-pounds. Now this 1 lb. of coal, by destructive distillation in a retort, will yield an average of 4·5 cubic feet of ordinary coal-gas, which, when completely burned, gives out 4·5 × 500,000, or about 2,250,000 foot-pounds of energy. Thus the coal-gas does not even give out in burning one-fourth of the total heat of combustion of the parent coal. Of course the coke resulting from the coal is valuable as a heating agent.

Again, with Dowson's gas apparatus 1 lb. of coal of calorific value equivalent to 11,000,000 foot-pounds of energy, will produce 70 cubic feet of gas capable of giving out in burning, a total amount of heat equivalent to 70 × 124,000, or 8,680,000 foot-pounds, showing that a considerable loss occurred in the gas-making process. Nevertheless, when this gas is used in an Atkinson cycle gas-engine of 16·7 horse-power, we find 1·067 lb. of solid fuel, consisting of 0·877 lb. of coal and 0·190 lb. coke, is capable of giving one indicated horse-power per hour, and 1·25 lb. gives an effective horse-power per hour; and in a large Crossley 118·7 horse-power gas-engine even better results are obtained, the expenditure of fuel being ·883 lb. per indicated horse-power, and 1·033 lb. per effective horse-power per hour. Very few steam-engines would give anything like so good a result, the average of large condensing steam-engines requiring 1·75 lb. of coals per indicated horse-power, or 2 lb. per effective horse-power per hour; and small non-condensing steam-engines use 5 lb. per indicated horse-power and 6 or 8 lb. of coal per effective horse-power per hour.

From a commercial point of view, the price of a producer and a steam boiler are much the same, and they might be taken to have the same efficiency, viz., 70 per cent. That is to say, of the total heat of combustion of the coals, 70 per cent. is found in the steam in the one case, and in the gas formed, available for gas-engine work, in the other.

Gas-engine *versus* Steam-engine.

The efficiency of the best steam-engine is about 10 per cent., and that is a very high figure for the ordinary run of steam-engines. That is, of the total heat available in the steam supplied to a good steam-engine, only 10 per cent. is converted, or appears as useful work. All the rest of the heat supplied in the steam is rejected by the engine or lost in various ways.

With gas-engines, an efficiency of 18 per cent. is common.

Comparing the combination, therefore, of a steam-engine and boiler with that of a gas producer and gas-engine, when the same fuel is used in both, the combined thermo-dynamic efficiencies are 7 to 10 per cent. of the total heat of the fuel in the case of the steam-engine and boiler, as against 12·6 to 15 per cent. in the case of the gas producer and gas-engine.

Thus, the simple and direct way to compare the efficiency of these combinations is to take in each case the weight of fuel (coal) used per effective horse-power per hour, and have the same kind of fuel used in both. In such a case it is no more necessary to know the volume of gas than the volume of steam used. If different fuels were taken, then we should compare the cost of working and the absolute efficiency, or the fraction the useful work done is of the total heat energy supplied in the fuel.

Here we have the important fact brought out, that the gas-engine has very much higher efficiency, as a heat-engine, than the steam-engine, even of the very best modern type.

Mind you, this is a comparison between the young, small, somewhat noisy, gas-engine, with its great future possibilities, and the large condensing steam-engine, practically perfect, from a mechanical point of view, and therefore "so much the worse for the steam-engine."

Further, in the petroleum-engine, which uses the oil directly in the cylinder, as oil without the 30 per cent. loss in the gas producer, we have already found a still larger proportion of the total heat of combustion of the oil converted into useful work.

The gas-engine, with its high efficiency, can be worked equally well with oil-gas; and, in this way, *heavy oils* can be employed for obtaining motive power, which cannot be used without trouble in the oil-engine proper.

Naphtha Vapour is not Oil-gas.

Of course we cannot ignore the obvious fact that the forbidden thing is always tempting to human nature, and, as a rule, is easily done, if it were not for the necessary precautions laid down and enforced by law for the public good. There is a great temptation to use deodorized

naphtha, of specific gravity from 0·7 to 0·77, instead of ordinary burning oils of specific gravity ·795 and upwards, in the petroleum-engine, because of the more complete combustion of the volatile spirit without residue or deposit and the greater power obtained therefrom. Again, a so-called oil-gas, or carburetted air, can be easily produced, by passing air through light petroleum spirit; but the explosive mixture thus obtained is not a true gas, and merely consists of air laden with petroleum vapour. This petroleum spirit is highly inflammable and dangerous, and should not be made use of or placed in the hands of unskilled persons, because it may explode, and cause serious mischief when least expected. It is not gas that arises from naphtha, but vapour; consequently, like all vapour, it condenses again at moderately low temperatures when subjected to pressure.

Oil-gas.

On the other hand, oil-gas made by splitting up by heat intermediate shale oil and the like oils, into a real and fixed gas, does not condense again appreciably at the coldest temperature in winter. Real oil-gas does not possess the dangerous and troublesome qualities referred to. Moreover, in case oil-gas escapes from a leaky pipe, it can at once be detected by its strong smell, like coal-gas.

In this respect oil-gas is superior to water-gas, that is, hydro-carbonic oxide or producer gas, which is scarcely perceptible by its smell, and consequently requires to be odorised, and due care taken to avoid bad joints in piping. Otherwise water-gas will by degrees imperceptibly overpower and poison those inhaling it, owing to the poisonous constituent carbonic oxide.

Oil-gas, then, which burns with excellent results in the gas-engine cylinder is a safe, rich, true gas, now generally made from petroleum oils and fats, too heavy to be easily dealt with in the ordinary oil engine cylinder, and which may be had at low prices. Thus the oil-gas plant comes in, as an auxiliary to the gas-engine, just where the oil-engine of the Priestman type finds trouble or stops.

Oils Suitable for Oil-gas Making.

It is curious to note that the light thoroughly refined burning oils, as common paraffin oil and petroleum, which answered best in the Priestman engine, do not make so good oil-gas as the partially refined petroleum and the heavier oils. Of these oils there is a great variety represented by the few samples before you on the table.

We have here a Scotch intermediate oil, got from Shale Works in Linlithgow, and called gas-oil, of specific gravity, varying from ·840 to ·865, and lowest flashing point 235° Fahr. close test. This oil costs £4 15s. a ton, and can be turned into very good oil-gas at the rate of 80 to 95 cubic feet per gallon. There is another intermediate oil of somewhat similar nature, from America, which costs £5 a ton in Liverpool, and would produce about 100 cubic feet of gas per gallon.

Even the still heavier oils, as Russian astatki or residuum from the distilleries and refineries of Russia, and the American residuum, also make excellent gas, one gallon producing about 100 cubic feet of oil-gas.

Apart from these mineral oils altogether, we may turn for a moment to the *vegetable* world, and find, for example, on the West Coast of Africa abundance of *palm oil* which yields excellent gas. So does *cocoa-nut oil* from the cocoa-nut palm. This sample is in the solid state, but it can be readily melted by a Bunsen burner. Then, of *animal oils*, in Australia the grease obtained in washing sheep's wool, as well as mutton fat and dripping, produce a very strong gas at the rate of 100 to 120 cubic feet to the gallon. The squatter in Australia has lots of this stuff to hand, and can easily make it into gas to drive the ordinary gas-engine.

In short, nearly all these fats and heavy oils can be converted into gas by suitable appliances.

Oil-gas Manufacture.

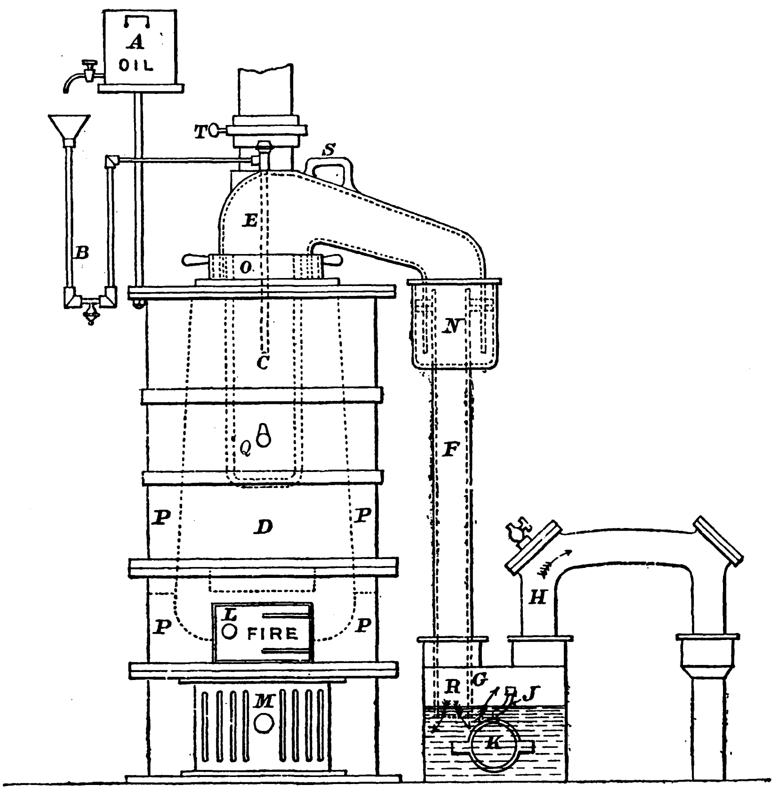
Gas is now generally made from *intermediate oil* or partially refined paraffin oil, by allowing the liquid to flow from an elevated cistern in a thin continuous stream, usually through a syphon, into hot quarters, where it is *vaporised* into a cast-iron retort at a bright *cherry-red* heat, which decomposes and converts the vapour into a "fixed" or permanent gas mixed with tarry products. The gaseous mixture is then allowed to pass freely through a wide pipe into a *hydraulic main* filled with water, which separates most of the tarry matter, and after further *washing* and *cooling*, without any pressure being applied, the oil-gas is led to the gas-holder, where it is cooled and stored ready for use in the gas-engine. This is the simple process adopted in small oil-gas plant.

For lighting purposes, the gas, after leaving

the hydraulic main, is taken through another water washer, and purified on its way to the gasholder by passing over a mixture of slaked lime and sawdust, in proportions of 2 to 1, spread in a layer 2 inches deep over a perforated tray. This mixture removes the sulphur compounds, carbonic acid, and other impurities. Finally, the gas is drawn from the gasometer by compression pumps, and forced into storeholders at a pressure of 150 lb. per square inch.

The quality of the gas, and the number of cubic feet obtained per gallon of oil, depend upon the *temperature* of the retort, as well as upon the *rate* at which the oil is allowed to run into it. The practical tests for regulating these during gas-making are (1) the colour of the gas, which should be nut brown, (2) a drop of the tar, from the hydraulic main, on a piece of white paper should not have a greasy border. Too fast oil supply gives a greasy rim around the spot of tar, and makes the gas white or too light brown; if dark brown, forming flakes of soot, the oil supply has to be increased and the temperature of the retort lowered.

FIG 27.



MANSFIELD OIL-GAS PRODUCER.

MANSFIELD OIL-GAS PRODUCER.

The Mansfield Oil-gas apparatus here in the room before you, and shown in section Fig. 27, is, undoubtedly, one of the simplest producers of its kind. The little model will also enable you to examine all the parts and arrangements for yourselves. (Model and actual producer were taken to pieces and the working explained.) The oil or melted fat contained in the little cistern, A, above the apparatus, is allowed to trickle down through the U tube, or syphon bend, S, into the pipe, C, leading into the retort.

This particular size of producer will allow about half a gallon an hour to flow through when working properly. The retort is heated up to the desired temperature by the fire at L, and the draught may be regulated by the grids, M, below the fire and the damper, T, in the smoke flue; whilst the colour of the retort, which should be bright cherry-red, is observed through the sight-hole, Q. The cast-iron casing, D, of

the producer is lined inside with blocks of fireclay, P, to keep the temperature uniform, and prevent loss of heat. The cast-iron retort, C, hangs by a flange on the fireclay cover, and is made thick at the bottom to stand the heat, and lasts about two years.

When *starting*, it will require an hour or two to get up sufficient heat for gas-making. The temperature is indicated by the melting of the lead seal in the annular socket, O, so that the bonnet, E, fits down into it, and the other end goes into the socket, N, kept filled with water, at the top of the standpipe, F. The lower end, R, of the standpipe dips into water in the hydraulic box, G, which is regulated by the ½ inch siphon bend, J, and the tar is cleared out occasionally at the door, K.

In *gas-making* the oil becomes thoroughly vaporised, trickling down the pipe, C, inside the retort; and the oil vapour, as it falls down, coming into contact with the sides of the retort, at bright cherry-red heat, becomes decomposed or split up and converted into a "fixed" gas and tarry products. The newly-made gas and tarry products escape through the large bonnet, E, down the stand-pipe, F, into the water, at R, in the hydraulic-box, where the tarry and other condensable products are washed out of the gas. It is important that the passage, E, should be large, to allow the oil-gas to come over freely, so that the mixture may not be subjected to the slightest pressure likely to cause condensation until the gas is washed and cooled. The gas passes by the arch pipe, H, and connecting pipes, to the gas-holder, where it is stored under pressure of only 1 inch of water, and, when cool, is ready for use in the gas-engine.

During the manufacture of oil-gas the retort must be carefully regulated, to keep the temperature uniformly at the proper point, because the quality of the gas produced depends more upon the temperature of distillation than even upon the quality of the *oil* used. The attendant can test the gas at the small tap in the arch pipe, H. The gas should be a nut-brown colour. A gentle pulsation of the lead, O, and in the water-seat, at N, is an indication of successful gas making.

With this apparatus, and Scotch intermediate oil, of specific gravity ·840 to ·865, about 8 gallons may yield 1,000 cubic feet of gas; that is, 1 gallon of oil produces 125 cubic feet, or 1 lb. of oil gives about 15 cubic feet of this rich oil-gas.

The calorific power of this oil-gas is about 864 British thermal units per cubic foot, so that these 15 cubic feet, by complete combustion, give out 864 × 15, or nearly 13,000 British thermal units, whereas the calorific power of 1 lb. of the parent coal is 19,800 thermal units. The efficiency of this small oil-gas producer thus works out nearly 66 per cent.

Again, the highest price of the intermediate oil mostly employed is £5 per ton, or about 4½d. per gallon. The fuel in the furnace costs less than 1d. per 100 cubic feet of gas made. Hence the total cost of fuel and mineral oil to make this rich oil-gas is about 6d. per 100 cubic feet. One labourer can look after both the oil-producer and gas-engine.

Now, take the average result, and we find that in ordinary working the yield is 100 cubic feet of gas per gallon, and a 12 horse-power Crossley gas-engine requires only 10 cubic feet of this gas per effective horse-power per hour; therefore, it appears that in the combination of Mansfield *oil-gas producer* and Crossley *gas-engine*, using intermediate oil, the cost of working comes out 0·6d. per effective horse-power per hour, and the fuel used is 1·15 lb. of oil per effective horse-power per hour.

Keith Oil-gas Producer.'

The first oil-gas plant used to drive gas-engines on a large scale was at Langness Point, Isle of Man, where the oil-gas apparatus, supplied by Mr. James Keith, of Arbroath, Scotland, is used in conjunction with the Crossley gas-engine to work fog-signals for the Commissioners of Northern Lights. The success of this oil-gas installation led to the still larger one on Ailsa Craig rock, Firth of Clyde.* On Ailsa Craig five Crossley gas-engines, each of 8 horse-power nominal, using oil-gas, work the air compressers for the siren fog signals.

Through the kindness of Mr. Keith I have here on the table one of the retorts used in his oil-gas producers. This retort is of cast-iron formed in this peculiar saddle-like shape, and inside of it, there are placed shallow cast iron gutters, into which the oil dripped and trickled down towards the hotter parts of the retort, where it is converted into gas, and led off through large passages to the hydraulic box to be washed, cleansed, and cooled. The main thing is to allow the gas free play when formed and to have it washed, and cooled before being subjected to pressure.

* See paper by David Alan Stevenson in "Proceedings Inst. C.E.," Vol. lxxxix, session, 1886-87.

In the retort-house there are three benches of Keith's oil-gas producers, having four iron retorts in each; 100 gallons of ordinary lighthouse burning paraffin oil, and 20 to 30 cwt. of coal are required to heat the retorts and to make 10,000 cubic feet of gas. The retort I hold in my hand would make about 300 cubic feet an hour, and a producer will have three of these, giving about 900 cubic feet an hour.

This gas is found to be too rich to give thoroughly complete combustion when escaping into the air in ordinary way, and especially the small burners for flame ignition gave some trouble. Hence, before use in the gas-engine, the oil-gas is mixed with about one-half its own volume of air, 35 parts of air to every 65 parts of gas, in order to bring it down to about the same strength as ordinary coal-gas, so that it can be used in the gas-engine without specially changing the valves, at the rate of 26 cubic feet of this mixture containing 16·9 cubic feet of the rich oil-gas per effective horse-power per hour.

The cost of the ordinary lighthouse paraffin oil used is 4½d. per gallon, yielding 100 cubic feet of rich gas, and the cost of coals for heating retorts, reckoned at 9·6d. per cwt. delivered, brings up the approximate cost of rich oil-gas 6·9d. per 100 cubic feet, exclusive of attendance. The cost of working comes out 1·16d. per effective horse-power per hour. This total cost is rather high, owing partly to the isolation of the plant, the ordinary refined lighthouse oil used, the freight, and cost of landing.

For small installations, Mr. Keith has designed a compact oil-gas producer with one double retort, bent into a **V**-shape, the section being the common ⌓-shape used in the larger retorts. The oil is well vaporised, and subjected to a bright cherry-red heat during its passage through this **V**-shaped arrangement, so that it is thoroughly gasified, and the columns of firebrick with flame playing all round, help to utilise the heat of combustion from the fire below.

Pintsch Oil-gas.

One of the best known gas producers and plant is the Pintsch* apparatus, which produces per gallon from once refined paraffin oil, 120 cubic feet of gas, equal to 40 candles, and 70 to 85 cubic feet of 50 to 60 candle-power gas. This gas is largely used for lighting of railway carriages, but is not much used for motive-power purposes, because in this country coal is so cheap that, on a large scale, the competition is rather between Dowson gas and ordinary steam, than between oil-gas and steam.

* See papers on "Compressed Oil-gas." "Minutes of Proceedings," Inst. C.E., vol. xciii., p. 298, *et seq.* *Ibid*, vol. xcv., p. 218, *et seq.* *Ibid*, vol. cx., p. 324, *et seq.*

Thwaite Oil-gas Generator.

The wall diagram shows the section, Fig. 28 (p. 1014), of a simple retort oil-gas generator, designed by Mr. B. H. Thwaite for the gasification of partially refined petroleum oils, intended to produce oil-gas suitable for gas-engines.

This generator enables oils of an inferior value to that suitable for ordinary petroleum engines to be used.

The generator, Fig. 28, consists of a sheet-iron drum lined with fireclay, forming a slow combustion chamber, in the centre of which is placed an iron retort. The inner part is heated by the slow combustion coke stove surrounding the annular space. The petroleum oil, allowed to trickle down the central tube, is first vaporised and partly gasified on its passage down, and, on reaching the bottom of the tube, this vapour is passed up the annular space between the central pipe and the inner side of the retort. This chamber is highly heated, and the vapour is converted into permanent gas by contact with the inside heated surfaces.

The suspended sediment falls into an inner grate, and can be removed from the bottom of the retort. The gas is led off at the top of annular chamber towards the right, and cleansed in the usual way, by passing through a condenser and purifier consisting of oxide of iron to the gasholder.

By means of this small oil-gas plant, oil of an inferior value, as de-hydrated petroleum at 3½d. per gallon, is made into gas fit for use in gas-engines.

Enriched Producer Gas.

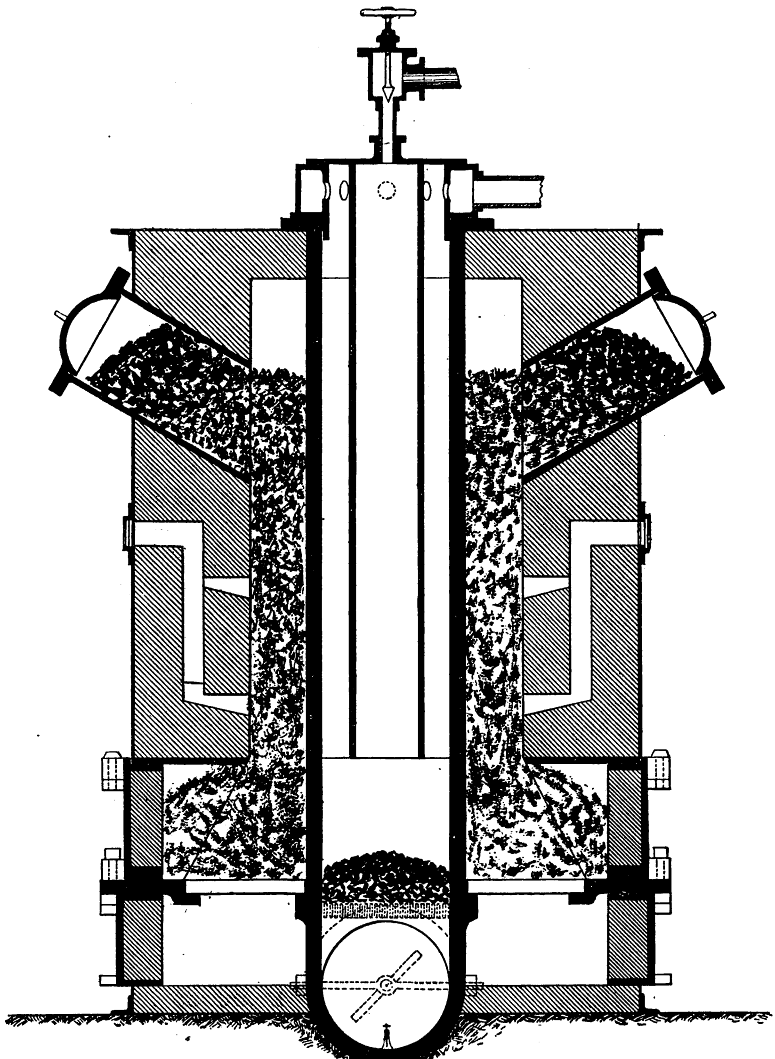
Mr. Thwaite has also devised a larger producer, in which ordinary producer gas is enriched by means of oil. Fig. 29 (p. 1015) shows the general arrangement of the complete plant for enriching water-gas. Fig. 30 (p. 1016) is a vertical section of the producer in the large gas-generating plant at the Southall Gas Works of the Brentford Gas Corporation.

The action depends upon the decomposition of hydro-carbons by heat, by which the oil is converted into a gas of fixed quality.

The cycle of actions is novel. There are two generator vessels (Fig. 30) working alternately. Both vessels are charged with coke or anthracite coal, which is fed into them by an ingenious and automatic contrivance, that not only elevates the fuel to the full height, but transmits it to the generators, into which it is fed regularly and certainly, and without loss of combustible gas.

Above the fuel in each generator, during one part of the operation, some of the gases generated in the vessels are burned, and the products of combustion are drawn through the flue connecting the two vessels into the second

FIG. 28.



THWAITE RETORT OIL-GAS GENERATOR.

vessel, through the incandescent fuel of which the products of combustion (H_2O and CO_2) are drawn, being split up in their descent into (H and CO) hydrogen and carbon-monoxide, which can be collected in a separate holder or utilised for diluting the results of the volatilization of the petroleum.

The cycle is alternately in one direction and then in another, the direction being reversed by automatic reversal valves.

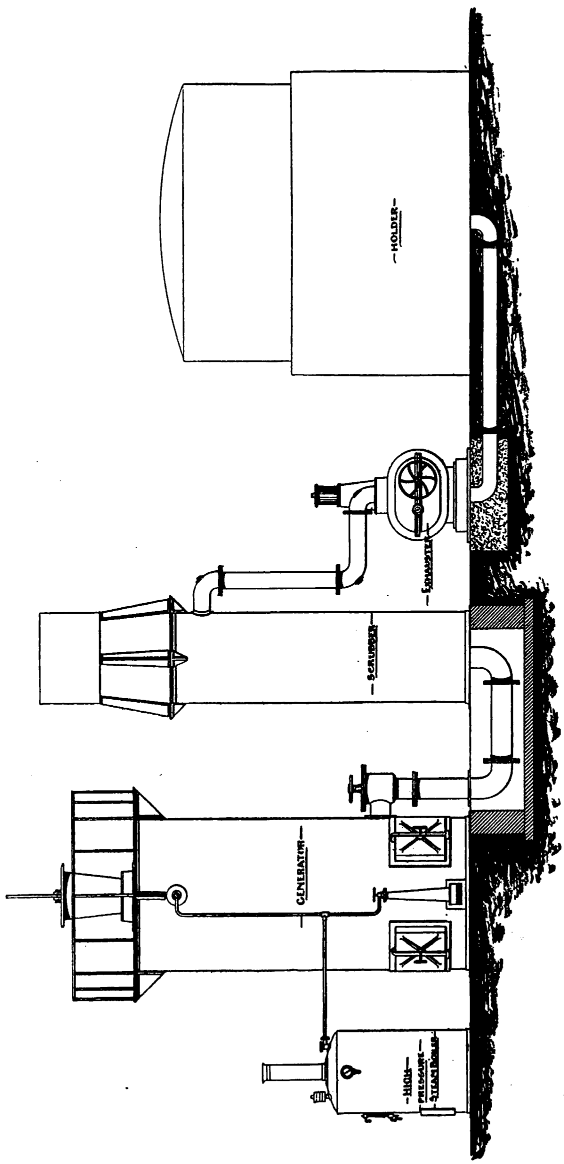
After four reversals, the air is shut off, the oil is then sprayed in by a steam injector (Fig. 29), and is immediately volatilised in one of the chambers; the oil-gas, along

with the steam, flows through the connecting flue (Fig. 30) into the second vessel; and, in descending through the incandescent fuel in second generator, the oil-gas is decomposed by heat into the higher of the hydrocarbon series, and is converted into a gas of a permanent character.

The permanent re-arrangement is the result of a catalytic combination of the hydrocarbon vapour with the steam at a certain temperature, depending upon the temperature of the steam, and the specific gravity of the injected oil.

The injection of oil continues in the Thwaite

FIG. 29.



ENRICHED WATER-GAS PLANT.—ELEVATION.

generator as long as the temperature of the fuel does not fall below a certain limit. When this limit is approached the oil is shut off, and the cycle already described is repeated.

In this way, the crudest oil is made available for use, and the gas leaves the generator in a fairly permanent condition.

The gas thus produced has about the same calorific value as ordinary lighting gas, and can, therefore, be used in a gas-engine, without necessitating any modification of its values.

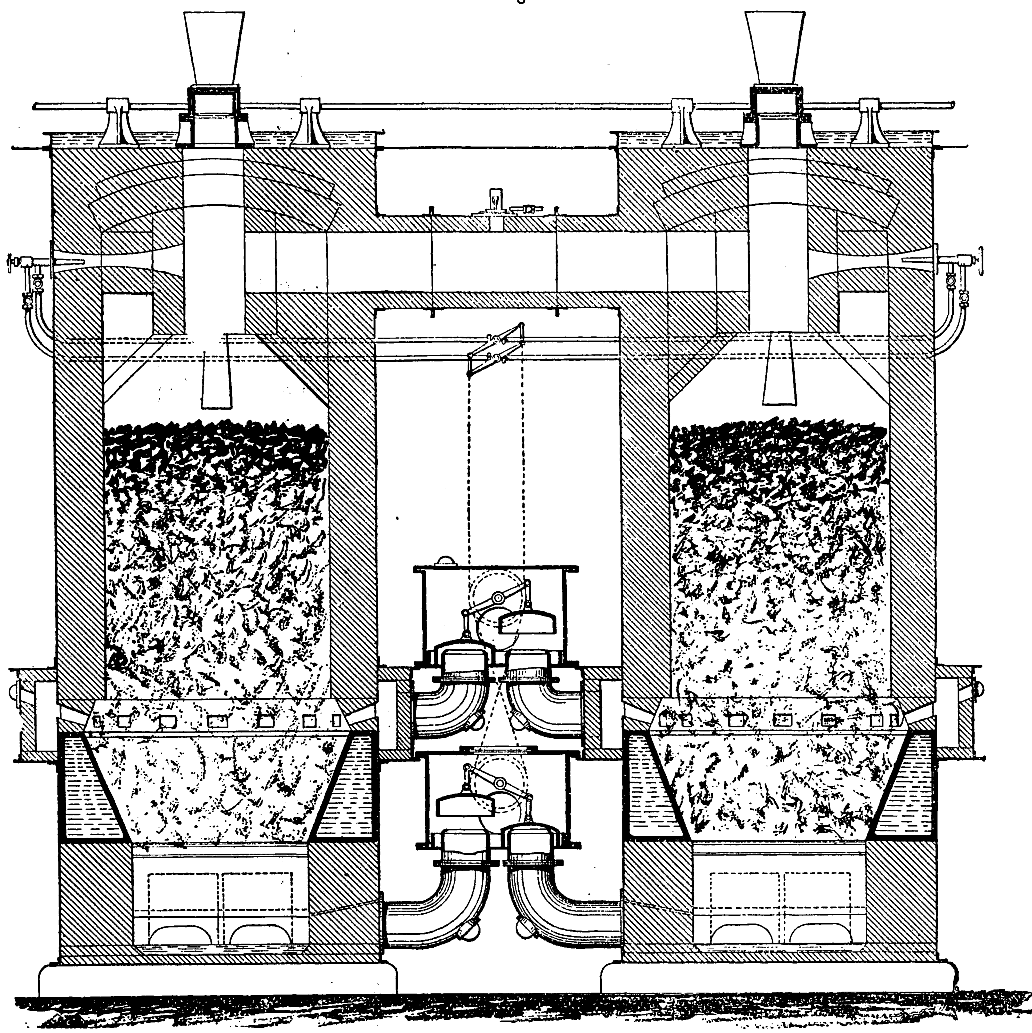
The proportions of valves and parts in the gas-engine are usually such as adapt it for work with ordinary lighting gas.

Consequently, for either very rich or poor gas the valves have to be specially designed. Moreover, for a given power or output, with a very weak gas, such as Dowson gas of only one fourth the calorific value of lighting gas, the moving parts of the engine must be made much larger, and the loss in friction thereby increased, giving a lower mechanical efficiency.

Now, by this apparatus you may enrich the producer-gas up to the same calorific power as ordinary coal-gas.

A simple expedient is adopted to show ordinary workmen the lighting value of the gas as it is produced. A standard light of known value, and under a given pressure, is maintained alongside another jet of the gas that is being produced, and under a like pressure the relative heights of the two flames show the relative values of the gases at a glance.

FIG. 30.



THWAITE GAS GENERATOR.

The cost of enriched generator-gas of a given calorific power mainly depends on the price of the oil. In fact, of the whole cost of working, about 95 per cent. will go for fuel, 3 per cent. anthracite or coke, and 2 per cent. labour.

With anthracite as the solid fuel, the labour and tar troubles are materially reduced, and the efficiency of the fuel is much increased. Taking crude petroleum at 50s. per ton at the works, the cost of the enriched gas, equal to ordinary London coal-gas in lighting and heating power, comes out not less than 1s. 8d. per

1,000 cubic feet, independently of the cost of condensation, purification, and the expenses incident to such work. With the price of oil at 70s. a ton, the cost of the gas, of the same calorific value, will run to 2s. 6d. a 1,000 cubic feet. This enriched gas is about equal to ordinary 16 candle London lighting gas. The calorific value may be taken at 630 British thermal units per cubic foot.

Continuous Producer.

With this intermittent and alternative or reversible method of working, the composition of the gas must vary considerably; and Mr. Thwaite employs a continuous working system which is a modification of the other. In this arrangement one of the two cupolas is charged with anthracite, and the second cupola with open refractory material.

The generator-gas is burned in the chamber over the fuel, and also over the refractory material. The effect of this combustion is to raise the temperature of the refractory material to a bright cherry-red heat, ample for gasifying the oil, which is injected, under high pressure, into the heated chamber above the fuel, where it is vaporised. This evaporation is assisted by breaking up the oil, by means of the steam-jet used in spraying it.

The oil-spray is immediately vaporised, and, passing into the second cupola, is brought into contact with the heated refractory surfaces.

There is decomposition due to the reaction between the steam and heated hydro-carbon vapours, resulting in the production of a fixed or true gas. This action proceeds as long as the temperature is maintained. The oil-gas is generated simultaneously with the producer, or carbonic oxide gas—the latter diluting or reducing the calorific value.

In order to renew the temperature of the vaporising and fixing cupola, all that is necessary is to shut off the oil supply and open the air valves, so that the generator-gas is continually produced and burned to raise the temperature to the required degree.

With regard to economy for gas-engines, such enriching plant can only be used where you have very cheap oil as waste product available, and the gas is made on a large scale.

Cost of Working.

Although, as we have already seen, the combined efficiency of the oil-gas producer and gas-engine, as a heat-engine, is 50 per cent. higher than the steam-boiler and steam-engine, yet from a practical point of view we must reckon the cost of the fuel employed. The price of best Welsh coal is 24s. a ton, that is 0·1286d. per lb., so that the cost of fuel alone, per effective horse-power, for a large condensing steam-engine, using 2 lb. per hour, comes to ·26d., and for a small non-condensing steam-engine, using 6 lb. to 8 lb. per hour, cost 0·77d. to 1·03d. At the very lowest price oil is 2½d. per gallon of 8·5 lb., that is 0·3d. per lb., or more than double the cost of coals in this country. Obviously, then, the gas-engine is working at a great disadvantage as regards the price of oil-gas supply, but, even under these circumstances, the cost of working compares favourably with the average run of small non-condensing steam-engines.

Further, there are other considerations, which change the question entirely, or, at least, materially affects the comparison. The first cost and attendance are practically the same in both cases. For a small plant, one unskilled labourer or stoker is quite sufficient to look after the gas-engine and gas-producer.

Besides, after making gas continuously for a whole day, the attendant can have that gas stored in a gas-holder, and afterwards used directly to supply the engine without any trouble. Herein lies the great advantage of the gas-engine, wherever intermittent work is required. You can start the gas-engine at a moment's notice. Not so in the case of the steam-boiler and engine. In order to be ready for work, you must first of all get up steam in the boiler, and, for intermittent running, keep the boiler standing in steam—an expensive proceeding—and, with fires banked, yet even then you cannot avoid waste of steam or extra expense of fuel, when the work to be done is not continuous.

Furthermore oil-gas may be very useful for other purposes, such as heating and lighting.

We thus see there are substantial advantages in favour of the use of oil wherever it is cheap and plentiful, also in manufactories where you have a waste-product in the form of some kind of inexpensive oil that may be readily converted into gas.

For large powers the practical point is the low price of coal hereabouts, except during long strikes, and there is the great advantage of the perfect mechanism of the steam-engine, which runs smoothly and steadily, without any objectionable noise or smell.

Consequently, it appears that in this country, taking the present prices of coal and oil, the

large oil-gas plant and gas-engine cannot compete with the large condensing steam-engine and high pressure steam boiler; however handy and useful the small oil-gas plant may be in cases where coal is very high in price, and the work to be done intermittent.

In isolated places, and generally for small powers, the favourite prime mover will be the oil-engine that uses the common refined petroleum oils, to be had in abundance in every part of the country, because this engine is self-contained, works steadily and satisfactorily, with efficiency about double that of the oil-gas engine system, and superior to any steam-engine of the same power.

Miscellaneous.

CULTIVATION AND PRODUCTION OF COFFEE IN COSTA RICA.

Coffee plantations are chiefly cultivated in the vicinity of the capital, San José, at an altitude of 3,711 feet above sea level; in the province of Cartago, 4,633 feet above sea level; in Heredia, 3,655 feet above sea level; and Alajuela, 2,950 feet above sea level. A recent bulletin of the Bureau of the American Republics states that the largest coffee plantations are to be found in Heredia and in Santo Domingo. "Coffea Arabica" is the species grown in Costa Rica. There is also the "Grecia" coffee, but it is not very much cultivated. Some years ago Liberia coffee was introduced, and its cultivation appears to extend throughout the Republic. When the shrub (Coffea Arabica) is four years old, it has reached the full amount of production; it is then from six to eight feet high. It blossoms in April or May. The berry in the first year of its existence is a dark green colour, changing to a yellowish red, and finally to crimson. A great amount of labour is necessary to keep the coffee plantations free from weeds. Workmen are provided with large sharp shovels, with which they cut down the weeds, and heap loose earth round the trunk to form low ridges. This earth serves to cover the weeds and hasten their decomposition. This operation is called, in the country, *aporca*, and is effected in May or June. During the winter months the operation is reversed. The ridges built up in summer are now spread out between the rows of coffee. This operation is called *desaporca*. The *aporca* is again done before harvesting, in order to have the ground clean, and to facilitate the picking up of the berries that fall during the harvesting. Finally, the *desaporca* is again done after the crop has been harvested. Once a year, as a general rule, the plantation is ploughed, but only on one side of the rows, the other side being left for ploughing in the next year. In order to prevent the coffee flowers from being damaged by the sun's rays, experience has proved that the coffee tree should not be left without shade. For that purpose banana trees are planted between each third or fourth row of coffee trees. Besides bananas, many other trees are planted, which, with their large branches, cover a great deal of ground. Special species of acacia have proved to be beneficial in the plantations of coffee, or *cafetales*. *Poró juiquininquil*, &c., are grown among the shrubs, and some of them bear excellent fruit crops. Pruning is performed in order to let air and light circulate freely among the trees, to facilitate their development, and to obtain the largest possible crop. The planters in Costa Rica are not all agreed as to the best method of pruning. Some think that no branches other than those which are dead should be cut off, while the majority know that great benefits may be derived from a judicious pruning, and that the future crops may be vastly increased. The latter not only cut off the dead branches, but also those that appear to be half dead. When the trees are five or six feet high, they are topped, to prevent them from growing out of reach. This operation is performed by pinching off the two new leaves which form the top of the tree. It has been calculated that, in 1890, on 8,130 coffee estates there were 26,558,251 coffee shrubs. Each tree produces from one to two pounds, and frequently five or six pounds of coffee in *oro*, that is to say, ready for the market. Harvesting begins as soon as the berries are quite ripe, usually from November to February. The gathering of coffee is done by men, women, and children. The harvesting is performed methodically. A man who takes care of the crops assigns to the *cafeteros* those trees which must be picked first. In the evening an ox-cart is driven to the places where the picking is going on, in order to load the coffee gathered during the day. As soon as the coffee is loaded, it is immediately taken to the factory and thrown into a brick tank, which is larger or smaller according to the size of the plantation. It is large enough to hold as much coffee as can be picked in a day. Water is allowed to run in, in sufficient quantities to thoroughly cover the berries, which are left to soak for a short time. The berries are then taken from this tank to the pulper, through a channel, by means of water. Pulping consists in the separation of the beans from the pulp in which they were enveloped by means of a machine composed of an iron cylinder covered by a sheet of copper, having its surface toothed. At a convenient distance from this cylinder there is a piece of iron, placed in such a way that no bean can pass through this part of the machine and the cylinder without being squeezed. The bruised beans pass through the teeth of the machine while the pulp falls to one side. The pulp is carefully gathered and piled up in heaps, where it ferments. Finally, it is used as a manure for coffee and sugar-cane. The beans coming from the pulper are covered by a

parchment-like membrane and saccharine matter. If these are not removed from the berries, they will dry easily or rot. For this reason a special fermentation is needed. Drying is one of the most important operations in the preparation of coffee, because if it were allowed to become too dry, it would lose weight, and present an unattractive appearance. If too wet it would become mouldy and spoil. The beans coming from the tank are spread on the *patios*, or drying floors, to a depth of two or three inches, and are constantly turned over with light rakes. When the beans are perfectly dry, which is known by the fact that they can not be dented with the finger-nail, and that they crack between the teeth instead of tearing, they are fit to be stored or peeled. Peeling, or hulling, has for its object the removal of the parchment skin that is still adherent to the dry bean. To perform this operation the beans are thrown into a circular basin with a broad channel or groove. Two or more wooden or stone wheels, moved by oxen or water power, run in this circular groove, which has been filled half or three-quarters' full with dry beans. In the centre of the basin, or *trilla*, an axis is fastened to the ground. From this two or more horizontal bars serve to move the wheels, which are kept running until all the dry beans have been separated from their parchment cover. From the *trilla*, coffee husks and dust are put into bags and thrown into a winnowing machine. The husks are blown out by the current of air, while the coffee, falling down, passes through different sieves. The uppermost sieves have round holes, which allow the sand, smaller beans, and stones to pass through, while the larger beans are retained. The second sieve has holes small enough to permit the sand and very small gravel to get through, but not the perfect coffee beans which fall by the front part of the machine. There is yet another skin, called "silver skin," that must be removed. The operation is the same as for peeling, but with lighter wooden wheels. The coffee, as it comes from the hulling machine, goes to the *pulidor*, for it requires to be separated into various sizes for market. The machine which performs this classification is called *clasificador*. It is composed of a long, horizontal cylindrical sieve, formed of galvanised or steel wire, divided into sections of different meshes. A very strong brush of the same length, but smaller, lies against, and turns with, the cylindrical sieve so as to prevent the coffee from choking the meshes. The *clasificador* is run by hand or by hydraulic power. In the first section the sand and dust fall down; in the next the small and broken beans; in the third large beans; while in the last the largest beans are delivered. The coffee from each division is gathered apart, and forms the first, second, or third class, and pea berry, or *caracolillo*. After this mechanical sorting, coffee passes through women's hands, who pick up and separate light coffee, foreign seeds, &c. This work is done on tables made specially for this purpose, and the coffee coming from these tables is put up in sacks, containing about 130 lbs. each, and shipped. The quantity of coffee exported in 1890 was about 34,000,000 lbs., valued at over $9,000,000. This is an increase in four years of 15,000,000 lbs.

THE BALATA TRADE OF PARAMARIBO.

Under the name of "balata," a substance resembling gutta-percha has been before the public more or less since 1859. Little, at first, was known about it, or of the plant from whence it was obtained, except that it belonged to the natural order *Sapotaceæ*, which furnishes true gutta-percha. More attention was, however, drawn to the substance during the year of the London International Exhibition in 1862, where it formed one of the exhibits from Demerara. Sir William Holmes, who was commissioner for the colony, sent a sample of balata to the Society of Arts in 1864, which is recorded in the *Journal* for February 26th of that year, vol. xii, p. 229; and again more fully in the same volume, p. 245, for March 4th. In this communication the tree is decribed as *Sapota Mulleri*, Miq. In the following year, namely 1865, some 20,000 lbs. were imported into England, since which time it was largely used by the India-rubber, Gutta-percha, and Telegraph Works Company at Silvertown, but it was given up on account of its becoming brittle and cracking upon exposure, so that a year or two back the imports to this country had dwindled down to fifty tons annually. Another impulse seems, however, to be given to this industry, for in a recently issued report from the Foreign-office on the trade of Paramaribo, it is stated that "the balata industry has just begun to attract attention, the exports in 1891 amounting to £11,949, as against £7,951 in 1890; and in 1892 there will be a large increase. It was only last year that this industry was considered of sufficient importance to be regulated by special laws. Laws have now been made, and, consequently, the balata industry has attracted foreign capital and labour, English, American, and local firms having taken over leases of land to prospect for, and to bleed the bullet tree. The new regulations require that every one taking out a concession shall deposit as security 1,000 florins (or £83 6s. 8d.), and guarantee that they will begin to work with a stipulated number of labourers within four months of the date of the grant; that competent overseers are employed to supervise the work and see that the trees are not destroyed. All the balata collected has to be delivered at the Government depôts to be weighed, and a tax of 10 cents Dutch (equal to 2d. per lb. or kilo) is collected on it. Large grants of land have been made to various persons to prospect for bullet trees, but there are still large tracts of unexplored forest available. The Government makes no charge for the land granted for exploration, but collects a tax on the products. The largest part of the

balata produced in this colony is exported to Demerara, and thence to England. The United States, as yet, take but a small share of it." It is now known that the tree which furnishes balata is the *Mimusops globosa*, Gaertn.

CHICAGO EXHIBITION BUILDINGS.

The correspondent of *The Times*, in the second (17th Oct.) of a series of articles on the Exhibition, gives the following account of the present condition of the ground and buildings:—

The first impression made upon entering the Exposition enclosure and going about the grounds is that, with few exceptions, the great buildings are practically completed, the whole aspect of the Fair showing a state of preparation much further advanced than one would have supposed possible so far ahead of the opening day, which is seven months off—May 1, 1893. The desire to have the buildings completed in time for the dedication this month has been the incentive for this remarkable progress. A cold winter may come, to retard outdoor work, but they are now away beyond risk of delay from this cause. Some of the interiors are not yet entirely finished, and scaffolding enfolds one or two of the great domes. Outside decoration and painting is everywhere going on, with a very large amount of the statuary and other outside ornamentation already in place. A week sees marvellous progress in this sort of work, most of the artistic adornments being ready. I hear that all the building contractors are substautially up to time in the progress of the buildings, most of which are ready for the reception of goods.

The preparation of the grounds has made great progress. The lagoons, canals, islands, and most of the bridges are finished; and also many of the lawns and footways. The terraces and walls adjoining these waterways seem to be almost entirely completed. The plaza or grand court, being still largely used for railroads and wagon-roads fetching in materials, has not yet had its surface arranged. The protecting wall, paved shore, and broad footwalk out in front of the Manufactures Building on the lake front, stretching from the steamboat pier northward to the British House, making a grand curved esplanade, which is one of the attractive features, are entirely finished. The terrace between the building and this footwalk, which is to be composed of lawns, kiosks, &c., has not yet been arranged. Flower beds are everywhere ready, but the flowers will no be set out until spring. Thousands of people go every day to the grounds and watch with interest the progress of the work. On fine Sundays as many as 15,000 have entered the gates. They pay a shilling a-piece, this source having already brought in £20,000, an item which will largely increase.

The United States battleship, which has been built up from the bottom of the lake behind a protecting breakwater at the upper pier, is practically finished, and looks lifelike from all along the lake front, its turrets, stacks, and towers rising above the deck, and long guns pointing over bow and stern. Here will be made the Government naval display. Almost alongside stands the solid-looking "Victoria House" of the British Section, occupying an admirable place in the foreground of the Exposition, overlooking the lake, whose waters reach within a few feet of its doors. The first storey is up and building progress is rapid. It is an English half-timber house of the 16th century, yellow terra-cotta being largely used in the lower storey with red-brick facing and mullioned windows. The upper portion will be of half-timber construction, with over-hanging and projecting gables. The building being in full view from all sides, each façade is treated architecturally. The plan forms three sides of a quadrangle, with the open side next the lake, enclosed by a raised terrace with balustrade. The interior will furnish offices for the British Section, and the principal rooms will be fitted up with wall panelling and elaborate ceilings, like some of the best English country houses. This house is a feature that is distinctly unique, and it attracts great attention. Colonel Grover, of the Royal Engineers, is here superintending the construction for the Commission.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, OCT. 31...Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Dugdale, "County Council Plans for Providing Technical Instruction in Agriculture."

TUESDAY, NOV. 1...Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Oldfield Thomas, "Mammals from Nyassaland." 2. Mr. R. Lydekker, "Zeuglodont and other Cetacean Remains from the Tertiaries of the Caucasus." 3. Prof. F. Jeffrey Bell, "Description of a Remarkable New Species of *Cidaris* from Mauritius."

WEDNESDAY, NOV. 2 ... Public Analysts (At the HOUSE OF THE SOCIETY OF ARTS) 8 p.m. 1. Mr. C. W. Heaton, "Note on a sample of poor, but undoubtedly genuine Milk." 2. Mr. Alfred Smetham, "Composition of an abnormal sample of Milk." 3. Dr. Bernard Dyer, "Note on a case of abnormal Milk."

Entomological, 11, Chandos-street, W. 7 p.m. 1. Mr. Charles J. Gahan, "Additions to the Longicornia of Mexico and Central America, with Notes on some previously recorded species." 2. Mr. W. E. L. Distant, "Contributions to a knowledge of the Homopterous Family Fulgoridæ." 3. Mr. Edward B. Poulton, "Further Observations upon Lepidoptera, 1888—1892." 4. Mr. Oswald H. Latter, "The Secretion of Potassium-Hydrate by *Dicranura vinula*, and the emergence of the imago from the Cocoon." 5. Messrs. Henry J. Elwes and James Edwards, "A revision of the genus *Ypthima*, principally founded on the form of the genitalia in the male sex."

THURSDAY, NOV. 3...Linnean, Burlington-house, W., 8 p.m. Rev. Professor Henslow, "A Theoretical Origin of Endogens through an aquatic habit."

Ladies' Sanitary Association, 22, Berners-street, W., 3 p.m. Miss Homersham, "Nursing the Sick."

FRIDAY, NOV. 4...Geologists' Association, University College, W.C., 8 p.m. Conversazione.

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No. 2,085. Vol. XL.

FRIDAY, NOVEMBER 4, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-ninth Session of the Society will be held on Wednesday, the 16th November, when the Opening Address will be delivered by Sir Richard Webster, Q.C., M.P., Chairman of the Council. Previous to Christmas, there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 16.—Opening Address by Sir Richard Webster, Q.C., M.P., Chairman of the Council.

Papers for which dates have not yet been fixed:—

"The Chicago Exhibition, 1893." By James Dredge.

"Transatlantic Steamships." By Prof. Francis Elgar, LL.D.

"The Disposal of the Dead." By F. Seymour Haden, F.R.C.S.

"The Copper Resources of the United States." By James Douglas.

"The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." By Prof. Frank Clowes, D.Sc.

"The Purification of the Air Supply to Public Buildings and Dwellings." By William Key.

"The Utilisation of Niagara." By Prof. George Forbes, F.R.S.

"Pottery Glazes: their Classification and Decorative Value in Ceramic Design." By Wilton P. Rix.

"The Chemical Technology of Oil Boiling, with a Description of a New Process for the Preparation of Drying Oils, and an Oil Varnish." By Prof. W. Noel Hartley, F.R.S.

"The Mining Industries of South Africa." By Bennett H. Brough.

"Ten Years of Progress in India." By Sir William Wilson Hunter, K.C.S.I., C.I.E., LL.D.

"Australasia as a Field for Anglo-Indian Colonisation." By Sir Edward N. C. Braddon, K.C.M.G., Agent-General for Tasmania.

"Indian Manufactures." By Sir Juland Danvers, K.C.S.I., late Public Works Secretary, India-office.

"Caste and Occupation at the last Census of India." By Jervoise Athelstane Baines, I.C.S., Imperial Census Commissioner for India.

"Mexico, Past and Present." By Edward J. Howell.

"Newfoundland." By Cecil Fane.

"New Zealand." By W. B. Percival, Agent-General for New Zealand.

Indian Section.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 19; February 16; March 9; April 6, 27; May 11.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 17; February 28; March 21; April 2, 16.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 24; February 7, 21; March 14; April 11; May 9.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

Prof. Vivian Lewes, "The Generation of Light from Coal Gas." Four Lectures.
November 21, 28; December 5, 12.

Dr. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." Four Lectures.
January 30; February 6, 13, 20.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Three Lectures.
March 6, 13, 20.

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.
April 10, 17, 24; May 1.

C. Harrison Townsend, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.
May 8, 15.

Howard Lectures.

A Special Course of Six Lectures, under the

Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

January 13, 20, 27; February 3, 10, 17.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 4 and 11, 1893, at 7 p.m.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Thursday, 3rd November. Present: Sir Richard Webster, Q.C., M.P., Chairman; Sir George Birdwood, K.C.I.E., C.S.I., M.D., Sir Edward Braddon, K.C.M.G., Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Francis Cobb, Prof. James Dewar, M.A., F.R.S., Major-General J. F. D. Donnelly, C.B., Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., F.R.S., Walter H. Harris, A. B. W. Kennedy, F.R.S., C. Malcolm Kennedy, C.B., J. Fletcher Moulton, Q.C., F.R.S., John O'Connor, Prof. W. Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Monday, 31st October. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, B. Francis Cobb, Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Sir Owen Roberts, M.A., D.C.L., F.S.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

ELECTRICAL COMMITTEE.

A meeting of the Committee on Electricity was held on Thursday, 27th October. Present: W. H. Preece, F.R.S., in the chair; Prof. W. Grylls Adams, M.A., F.R.S., Prof. W. E. Ayrton, F.R.S., Major-General E. R. Festing, F.R.S., Prof. George Forbes, M.A., F.R.S., J. E. H. Gordon, Prof. David E. Hughes, F.R.S., W. M. Mordey, Mark Robinson, Alexander Siemens, C. E. Spagnoletti, Major-General C. E. Webber, C.B., James Wimshurst, with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

CANTOR LECTURES.

USES OF PETROLEUM IN PRIME MOVERS.

BY PROFESSOR W. ROBINSON, M.E.,
Assoc. M.Inst. C.E., University College, Nottingham.

Lecture IV.—Delivered March 21, 1892.

OIL-FUEL FOR STEAM BOILERS.

The fourth use of oil in prime motors is as fuel instead of coal or wood to raise steam for the production of mechanical energy. Perhaps the use of oil as fuel dates further back than any other application of it that we have considered. Rock-oil is frequently referred to in the Bible and other ancient historic records. Job said, "the rock poured me out rivers of oil;" and the spies sent by Moses into the land of Canaan found amongst other good things oil flowing from the rock, which was doubtless used to give both light and heat from the earliest times.

You are well aware that hitherto by far the most extensive use of the valuable products of petroleum, with flashing point from 73° to about 150° Fahr., has been for lighting purposes.

Now, besides the intermediate oils, considered in our last lecture, there are valuable heavy oils used for lubrication, whilst the still heavier cheap oils, available for liquid fuel, are mainly obtained (1) as residue or waste products from the mineral-oil industry, and (2) as liquid hydrocarbons recovered from coal-fed blast furnaces, coke-ovens, and gas-producers, known as blast furnace oil, creosote, and common tar-oils. These cheap oils, or heavy waste hydrocarbon products, cannot be easily converted into gas of a fixed character by direct volatilisation, because the gas formed by heating these liquids in a closed vessel at a high temperature, rapidly condenses again

into its original liquid state, when cooled and subjected to pressure. What then is to be done with these products? You will, I think, hold with the poet—

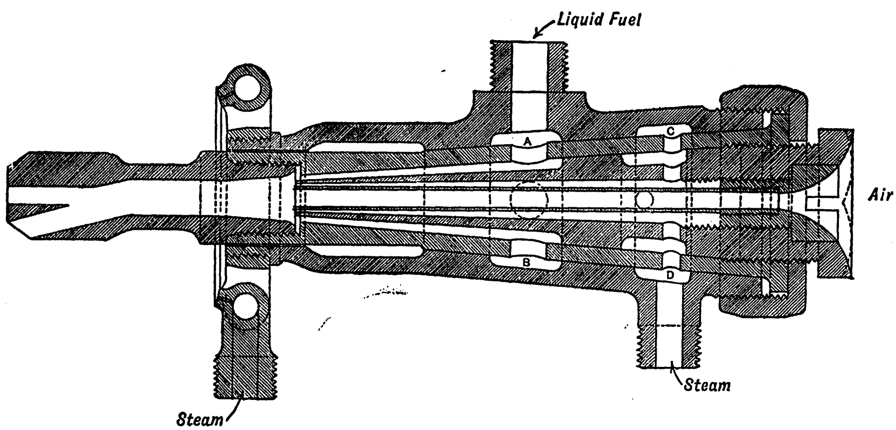
> "That not one drop should be destroyed,
> Or cast as rubbish to the void."

In fact, if you bury the tar, a troublesome waste product that is formed from oil-gas making, it will appear again where least expected, as it did at Stratford in the water mains when rejected from the Great Eastern Oil-gas Works. Therefore, to get rid of such oils effectually, the best way of all is to utilise them as liquid fuel for steam raising, and by this means take advantage of the great improvements which have been made in steam-engines during the last half-century.

Methods of Burning Liquid Fuel.

The simplest method is that adopted by Mr. Ludwig Nobel, at Baku, in burning astatki, the petroleum refuse for steam generating purposes under stationary boilers, by means of "trough burners" like that I hold in my hand. These shallow troughs are arranged in a series one above the other, exposing a large surface, so that the oil trickles or flows down from one stage to the other, and is thus vaporised, ignited, and finally the whole mass is completely burned. With this system of trough burners under a steam-boiler, a practical evaporation of 14½ lbs. of water per pound of petroleum refuse is obtained, whereas a spraying arrangement gives an evaporation of 12 lbs. with this astatki, whilst coal in the same boiler gives an evaporation of 7 lbs. to 8 lbs. of water per pound of fuel.

Fig. 31.



Holden's Injector Burner.

However, the most common and practical method of burning liquid fuel is to spray it into a specially prepared combustion chamber by a jet of superheated steam, through an injector which draws in the air supply at the same time. The oil is thus heated and broken up into the finest spray by the steam, and thoroughly vaporised in the furnace, where it is also mixed with the air, which supplies the oxygen for combustion.

A most important essential is the lining of the furnace or combustion chamber inside with fire-clay or brickwork, to act as an accumulator of heat and keep up a constant high temperature for complete combustion. To this end the fire-bars are usually covered with a layer of fire-brick and fuel, kept incandescent, and the oil is sprayed towards the fire-brick wall or lining. Sometimes hot air is drawn in by the injector and admixed with the oil and superheated steam, causing perfect atomising of the oil.

Holden's Method of Oil-firing.

Take, for example, the system of burning liquid fuel used by Mr. James Holden, locomotive superintendent of the Great Eastern Railway.

Fig. 31 shows a section of the spray-injector (actual injector shown and explained), so arranged that the liquid fuel is allowed to enter at the top and flow down around the passage, A B. The steam enters by C D, and is guided towards the nozzle through the annular passage between the oil-fuel outside and the central tube for the incoming air.

The parts are so proportioned that the liquid fuel is well heated and broken up into fine spray as it is drawn in by means of the steam jet. An auxiliary and entirely independent supply of steam is introduced by the hollow ring surrounding the orifice, and issues through a number of holes converging towards the nozzle of the injector, so that the steam jets from the ring play across the issuing jet of liquid fuel already atomised into spray by the central steam jet and bar in the nozzle of the orifice. The liquid is thus divided into the finest spray, vaporised by the heat, and mixed with a large supply of air drawn in through the central orifice at the back end. This supply of air can be varied by the steam inducing it to get the right amount of air for perfect combustion. The ring supply of steam breaks up the main central jet, so that the whole fuel burns with a flat intense lambent flame, not sharp nor directed like that of a blow-pipe.

The central part of the injector proper is screwed into the casing to facilitate removal, if blocked or damaged on a journey, and to clear away any obstructions without having to shut off either steam or fuel, although the steam blowing through the nozzle keeps it clean.

A modification has been made in these injectors, fitted on the latest express locomotives. The central steam-jet has been slightly altered to form an air injector, and the central cone has communication by means of a flexible hose with the main train pipe of the automatic vacuum brake, so that the air may not be drawn in from the surrounding space merely. The steam used, therefore, in the ordinary injector to spray the liquid fuel is further utilised in creating a vacuum available for purposes other than brake power.

Experience shows that superheated steam is much more economical than wet steam for injection.

The sectional elevation, Fig. 32 (p. 1025), shows the whole firing arrangement on the passenger tank locomotives. There is an oil-tank, F, supplied with oil through a sieve, or strainer, to prevent heavy particles in the oil, which flows along the pipe, D, into the injector, B, and is forced by the steam jet, A, into the open space above the firebars. There may be a coil of steam piping fixed in the tank, F, to heat up the oil in very cold, frosty weather. The firebox is fitted with a fire-brick bridge, towards which the jet is directed, and the bars of the grate are covered with a very thin layer of incandescent fuel, consisting of coal and cinders, mixed with chalk or lime, which keeps up the temperature, and is not merely for burning purposes. The coal burns slowly away, and is renewed to retain an incandescent base on the fire-bars, sufficient, with the fire-brick bridge, to accumulate the heat, and keep the temperature high enough for the decomposition of the oil in the presence of steam, and for the various reactions resulting in the gasifying and complete combustion of the oil.

These express engines can be run with coal without requiring any alteration to the furnace, a point of great importance in countries where the price of oil is high or fluctuating. In fact, coal can be used in an engine at one time, and the next run the liquid fuel. The oil used by Mr. Holden is a mixture of two parts of *coal tar* with one of *green oil*, just to thin it down, the cost being about 1½d. a gallon, or 25s. per ton.

Hydrocarbon refuse, oil-gas tar, creosote, and furnace oils are also used, and one ton of this is found to be nearly equal to two tons of steam coal; but all are inferior to either crude petroleum or petroleum refuse, as, on account of their greater weight, they require more steam for spraying, as well as being inferior in calorific value. At present, however, the price of petroleum refuse is against its adoption in this country.

On the Great Eastern Railway, Mr. Haldane finds that, using oil on an express engine, the consumption of fuels for one month's running has been—

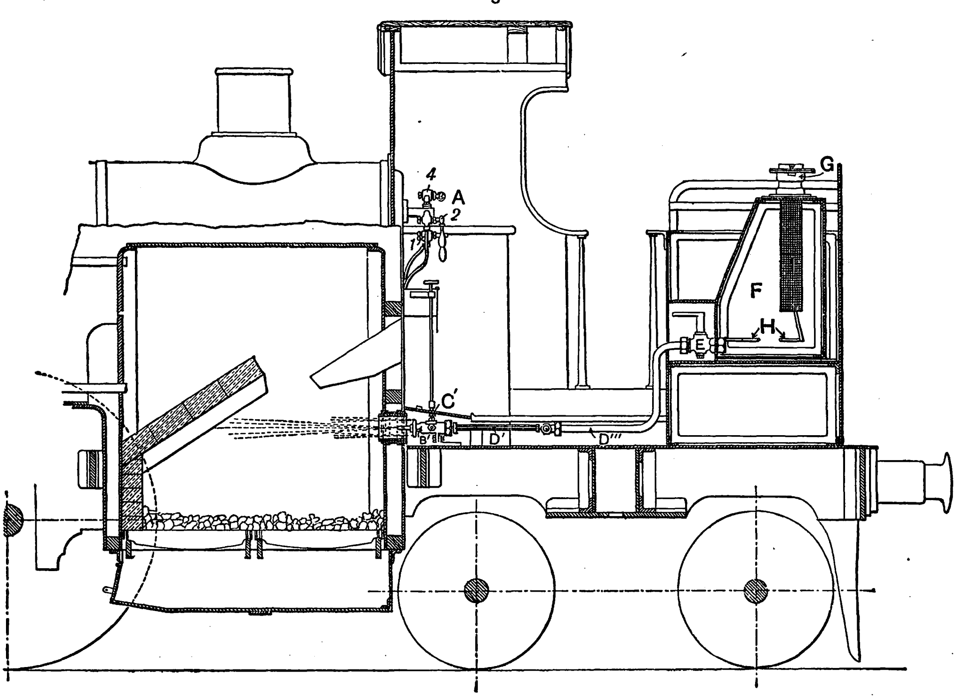
	Per mile run.
Liquid fuel	12·2 lb.
Coal and coke	11·0 lb.
Total	23·2 lb.

including lighting fires and working two systems of continuous brake constantly, viz., Westinghouse for Great Eastern Railway trains, and vacuum for foreign trains.

The consumption of coal on nine engines of the same class, doing similar work, but *not* always working vacuum brakes, averages 34 lb. per mile.

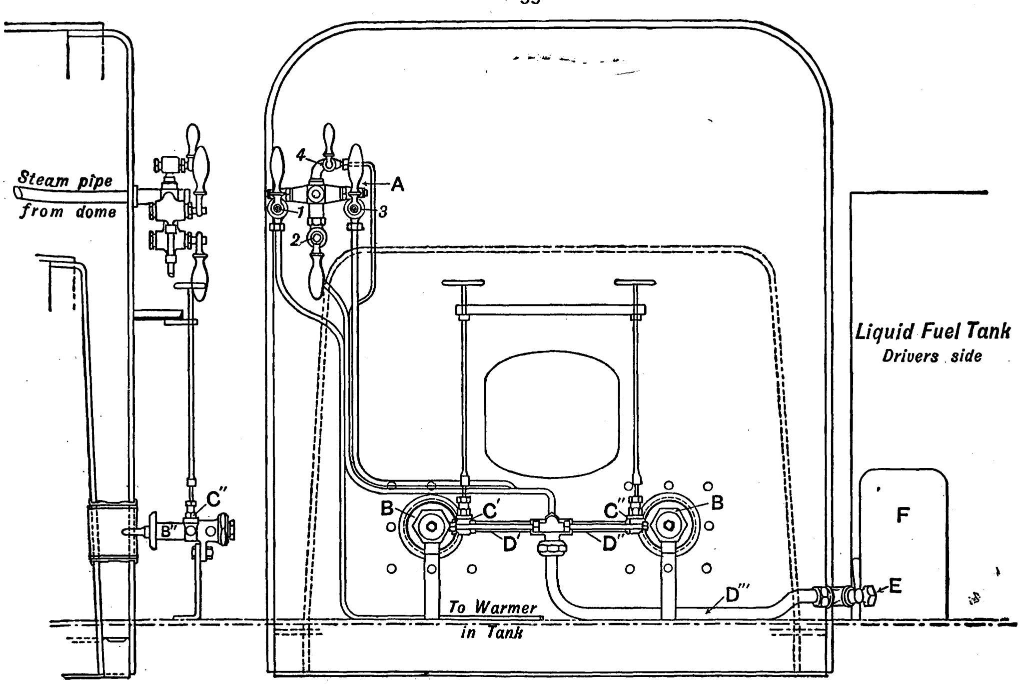
This system of liquid fuel firing has been adopted on the Great Western Railway in the Argentine Republic, where the copious oil deposits are being developed. Fig. 33 (p. 1025) shows to the right an end view of the eight coupled tank locomotives fitted with the oil-firing apparatus. To the left of the same drawing (Fig. 33) is shown the ingenious arrange-

FIG. 32.



HOLDEN'S OIL-FIRING IN LOCOMOTIVES.

FIG. 33.



OIL-TANK LOCOMOTIVE.

ment for staying the boiler at the point where the injector is fitted. At the top is seen the pipe from the dome conveying superheated steam to the injector. Dry steam gives much more complete combustion than wet steam saturated with moisture, which tends to dull and blacken the fires. In fact, by closing the tap leading to the ring jets I instantly stopped complete combustion, and sent a cloud of smoke up the chimney which on board might be used to signal orders.

On this line the consumption of coal on an ordinary engine is 33 lb. per mile run; but on a liquid-fuel burning engine, fitted similar to above, the consumption is 10lb. of oil and 12lb. of coal and wood, making the total 22 lb. per mile. I need hardly point out that the saving here in favour of liquid fuel is considerable, when coal is put down at £4 per ton and oil costs 48s. per 2,071 lb., the cost of fuel per train mile being 14·18d. and 8·19d. respectively. If each engine runs 18,000 miles per annum, the difference in cost of fuel alone is £450 in favour of the engine burning oil, coal, and wood. At the same time, if these engines were altered to burn oil only, precluding the use of coal, the railway company would soon have to pay more for the oil, the wells being in the hands of a native company. As it is, the engines are equally serviceable with coal as with oil.

The comparative results came out somewhat similar on the Tralee and Dingle Railway, Ireland, where Holden's apparatus is fitted on some of the engines. Taking an average train, the consumption of coal alone on the round trip, Tralee to Dingle, not including steam raising, was 27 cwt., at a cost of 1s. 2d. per cwt. With coal and creosote oil, and a certain amount of broken limestone, the consumption of coal was 4 cwt., and of oil 95 gallons, at 2½d., or just 1½ gallons to the mile. The saving effected with coal and oil is thus 7s. a trip. The results work out average consumption of coal 54 lb. per mile, whereas on the liquid-fuel engine, coal 8 lb. and creosote-oil 18 lb., makes the total consumption of fuels 26 lb. per mile. Here I should mention that this railway is over a mountainous country, with inclines of 1 in 30 for lengths over 3 miles. The excessive fuel consumption is due to the heavy grades, new locomotives, &c. The liquid fuel can be shut off on all the down grades, thus greatly economising the fuels. In this case the automatic vacuum brake is worked as already mentioned, probably saving the equivalent of 3 lb. of coal per mile.

Holden's injector, with liquid fuel firing, arranged as shown in Fig. 34 (p. 1027), in the steam ferry-boat *Middlesex*, on the Thames, gives satisfactory results. The fuel used is a mixture of two parts of coal-tar and one of green oil, o thin it down.

The mixture of coal-tar and green oil costs about 1½d. per gallon, or 25s. per ton. Hydrocarbon refuse, oil gas-tar, creosote and furnace oils are also used, and one ton of this is found to be nearly equal to two tons of steam coal, but all are inferior to either crude petroleum or petroleum refuse; as, on account of their greater weight, they require more steam for spraying, as well as being inferior in calorific value. At present, however, the price of petroleum is against its adoption in this country.

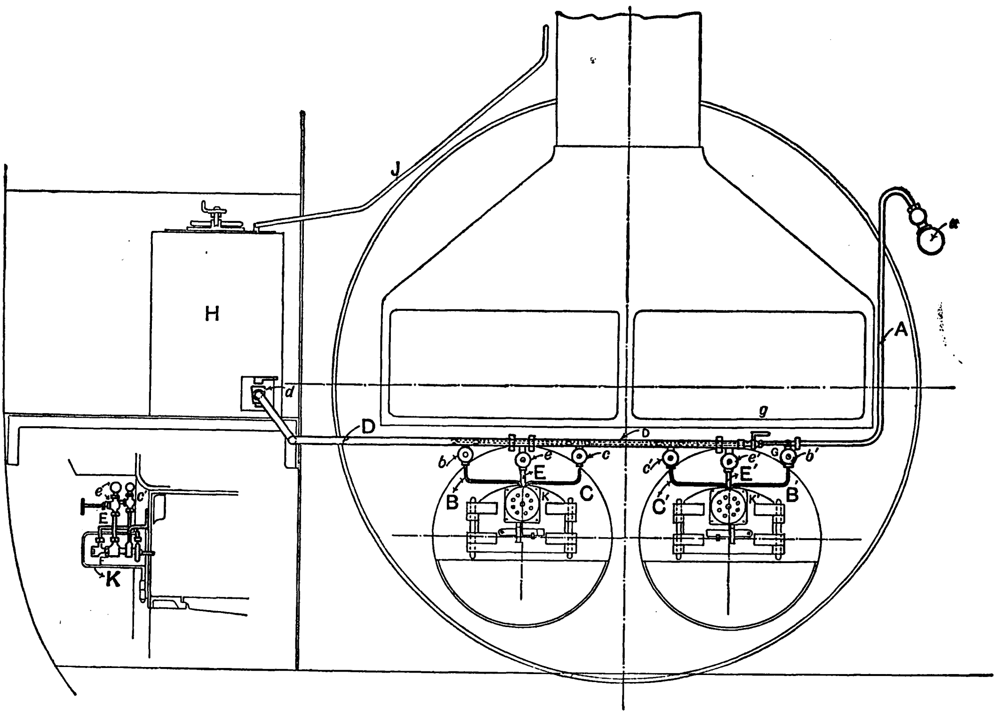
Blast-furnace oil is used to fire stationary boilers in various places throughout the United Kingdom.

Injectors.

Many modifications of these injectors have been proposed to atomise these heavy liquids into spray for burning in the furnace. Here is Thwaite's injector (Fig. 35, p. 1027), which is rifled so as to give the liquid a spiral motion, and thereby mixed the sprayed oil and steam more intimately with the air drawn in through the injector. Again, this injector may be used with an auxiliary hot-air supply by a forced blast, as in the torpedo boat arrangement, Fig. 36 (p. 1027). The hot-air blast aids in the vaporisation of the oil, giving more perfect combustion.

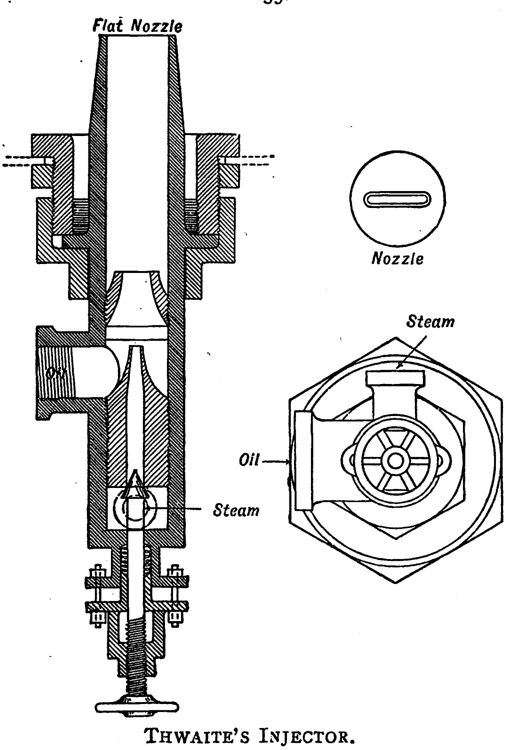
The air-blast can be adjusted to a nicety by the annular nozzle at the one end of the large drum or trunk, Fig. 37 (p. 1028), which you see here on the table. Mr. Thwaite, by this means, uses a minimum quantity of steam. The blast of air comes down the large tube, and the oil is sprayed by steam down below (Fig. 37), using the injector shown in section, Fig. 35. Only enough steam is admitted to spray the oil; the blast of air does the rest. This air-blower, combined with oil-spray injected by steam (Fig. 37), when applied to the furnace or combustion-chamber with fire-brick wall, as in Fig. 36, can be made to give complete combustion. The idea of vaporising the oil-spray is carried still further, as shown by the wall diagram, in which the spray does not pass directly into the fire-box, but first into a red-hot drum, where the oil is converted into fixed oil-gas before being mixed with the air-blast and burned.

FIG. 34.



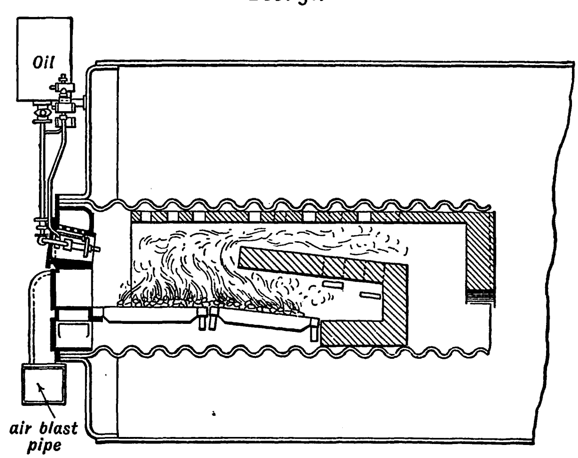
OIL-FIRING IN STEAM FERRY "MIDDLESEX."

FIG. 35.



THWAITE'S INJECTOR.

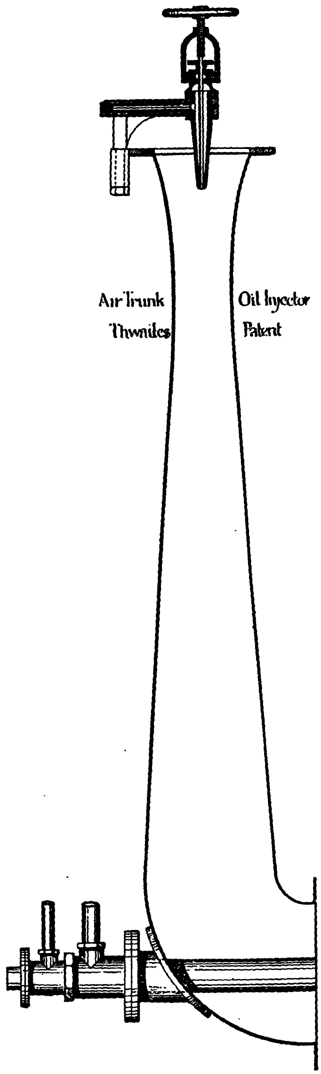
FIG. 36.



OIL-FIRING IN TORPEDO BOAT.

One trouble with most of these injectors is the noise produced by the high-pressure steam passing in. The noise is lessened in the Bray-Smith injector, which you see here, by this large hollow drum at the end. Air is drawn in through these holes in the drum to atomise the oil, whilst the rods across the end of the

FIG. 37.



AIR-BLOWER, WITH SPRAY-INJECTOR.

drum break up the oil-jet still further, and the oil is burned with a diffused, lambent flame, and not the objectionable, blow-pipe flame, which played against one particular part of the boiler-plate or fire-rick.

The most complete and successful system of employing petroleum refuse as fuel in steam boilers and locomotives has been worked out by Mr. Thomas Urquhart, on the Grazi and Tsaritsin Railway, in South-east Russia.* In this locality petroleum refuse, or astatki, is plentiful, and costs 13s. 7d. per ton, whilst the price of coal is 27s. per ton. Since 1884, he has had 143 locomotives under his superintendence, fired with petroleum refuse, besides fifty stationary boilers and several furnaces. It certainly appears that these nine years' experience of the system has shown a notable economy to result from using the heavy astatki, or petroleum refuse, as fuel. In ordinary locomotive practice an evaporation of $12\frac{1}{4}$ lbs. of water is obtained per lb. of petroleum refuse, and the highest actual evaporation 14 lb. of water per lb. of fuel at an effective pressure of 125 lb. per square inch from feed water at 60° Fahr. This result was obtained in a perfectly clean locomotive boiler, with new solid-drawn copper tubes ·079 inches thick and $2\frac{1}{8}$ inches diameter. Again the average consumption of *coal* in eight-wheeled coupled locomotives throughout the year 1882 was 79·98 lb. per engine mile, as compared with the average 40·47 lb. of *petroleum refuse* per engine mile during 1887. Also in special trials of the eight-wheeled engines, the result per ton mile was that forty-five tons of petroleum refuse were equivalent to 100 tons of anthracite, being a reduction of 55 per cent. in weight of fuel. Mr. Urquhart states that these comparisons were made with the greatest care possible, with engines in first-class order, showing the highest efficiency in locomotive practice. He has no hesitation in saying, that "with a locomotive in first-class order, and in the hands of a skilful driver, fifty tons of petroleum refuse are equal to 100 tons of first-class coal."

CALORIFIC VALUE OF LIQUID FUEL.

We must guard against exaggeration as to the calorific power of oil fuel, and, in making our estimate, keep in view the actual conditions that obtain in practice.

From the careful and elaborate experimental researches of Messrs. Fauvre and Silbermann, Dr. Andrews, and others, we know the quantity of heat obtained by the complete combustion of 1 lb. of solid *carbon*, when burned in pure oxygen in a calorimeter surrounded with cold water; and also the heat generated by burning 1 lb. of *gaseous hydrogen* under similar conditions. Then assuming, from the ultimate chemical composition of a fuel, that it is

* "Proceedings Inst. Mech. Engineers," 1889, p. 36.

made up of solid carbon and gaseous hydrogen, mixed loosely together in certain proportions, we may make a rough estimate of the heating value of the fuel, by calculating the heat given out by these constituents burning separately. Here we entirely ignore the obvious fact, that the amount of heat generated by the combustion of a fuel depends not only upon its physical state, but also upon its proximate chemical constitution, which may be wholly unknown. Moreover, it is well known that numerous hydrocarbons, having different properties, are made up of the same proportions of carbon and hydrogen, and yet give out different amounts of heat in burning, because of the heat spent in the internal work of tearing the ultimate particles apart where the carbon and hydrogen are more tightly held together in the more stable substances. In the simple case of pure carbon, the quantity of heat evolved, in burning the different varieties of carbon to form carbonic acid, changes with the density. Favre and Silbermann found the following values for the calorific power:—

	Pound-Centigrade Heat Units.	Pound-Fahr. British Thermal Units.
Carbon of wood charcoal....	8,080·0	14,544
Gas retort carbon (denser) ..	8,047·3	14,485
Natural graphite	7,796·6	14,034
Diamond	7,770·1	13,986

Notwithstanding this variation, the value generally taken for the carbon in liquid and solid fuel alike is that of wood charcoal, although the calorific power of carbon vapour is 11,214 calories, or 20,185 British thermal units.

Again, a similar error is made in calculating the calorific power of hydrogen in various hydrocarbons as if it were in the separate gaseous state in the liquid fuel, which we know is not the case. Then gaseous hydrogen is burned in pure oxygen to form steam, and in the calorimeter there is reckoned not merely the heat generated during the combustion, but that evolved in cooling down the steam to the boiling point, also in condensing the steam and subsequent cooling of the condensed steam down to the ordinary temperature of the atmosphere (59° or 60° Fahr.), and the sum of all these quantities of heat is called the calorific power of hydrogen.

Now, when burning a fuel containing hydrogen in the ordinary furnace, we do not condense the steam and cool the water formed to 60° Fahr. Consequently, we cannot expect to find the total heat value of hydrogen realised. In the same way, when carbon is burned to form carbonic acid, the heat evolved in simply cooling this gas is reckoned as part of the heating power of the carbon. In the experiments of Favre and Silbermann only very small quantities of charcoal, about 38 grains, were burned at a time, and a variable proportion, sometimes 30 per cent., of carbonic oxide was found among the products, showing incomplete combustion or reduction of carbonic acid gas formed, and thus necessitating corrections in order to arrive at the total heat that should be evolved in the complete combustion of the solid carbon with oxygen. These conditions do not closely agree with the physical state of carbon in liquid hydrocarbons, which are readily decomposed in the presence of high pressure steam, yielding gaseous hydrocarbons, especially compounds like olefiant gas, having a high heating power, with deposit of solid carbon. Marsh gas, CH_4, is found, by experiment, to develop 2,672 heat-units per pound less, whilst olefines give out more heat than the ordinary calculation would indicate.

It would, therefore, appear better, in dealing with petroleum oils as fuel, to gain some idea of the proximate chemical constitution of an oil, of the constituent fractions or gases into which it is most likely to be split up by heat as in fractional distillation or in the furnace, and to base the estimate of heating power as that of the gases produced therefrom. Thus mineral oils yield a large proportion of olefiant gas and marsh gas.

When burning solid fuel, it is necessary to introduce into the ordinary furnaces about twice the amount of air required to furnish the oxygen for combustion. Part of the generated heat is spent in raising the temperature of the excess air or nitrogen. In the case of liquids, less surplus air is required, and gases are still more favourable for perfect furnace conditions.

Bearing in mind the uncertainty about the calculation of the calorific values of these oils, founded on the ultimate chemical composition given from analysis, we shall proceed to estimate the heating value of a sample or two in the ordinary way.

According to calorimetric experiments, the total amount of heat that can be obtained at ordinary atmospheric temperature, 60° Fahr.,

by the combustion of the fuel and subsequent cooling of the burnt products, including condensation of steam formed, is from

	British Thermal Units.
1 lb. of pure carbon,	about 14,500
1 lb. of hydrogen,	about 62,000

If, then, C and H stand for the per-centages of carbon and hydrogen present in 1 lb. of the fuel, its total heat of combustion in calorimeter, when the steam produced is condensed, is given by the sum of the products

$$14{,}500 \times C + 62{,}000 \times H.$$

All the other constituents are neglected.

Now, since the heating value of hydrogen is nearly 4·28 times that of carbon, we may write the simple approximation to the heating power thus :—

$$\left.\begin{array}{r}\text{Calorimetric value}\\ \text{1 lb. of fuel.}\end{array}\right\} \begin{array}{l}\text{British thermal units.}\\ = 14{,}500\,(C + 4{\cdot}28\,H.)\end{array}$$

Professor Rankine pointed out that a convenient thermal unit for evaporation is the heat required to evaporate 1 lb. of water under the mean atmospheric pressure of 14·7 lb. per square inch, the water being supplied to the boiler at 212° Fahr., or 100° C., the boiling point of water. This unit of evaporation is the quantity of heat required to evaporate 1 lb. of water at 212° Fahr., that is, the latent heat of evaporation, which is 966 British thermal units. The *evaporative power* of a fuel is the number of pounds of water that 1 lb. of the fuel can evaporate at mean atmospheric pressure from and at 212° Fahr.

If we start with water at the ordinary temperature, say 62° Fahr., and heat 1 lb. of it up through 150° to the boiling point 212° Fahr., we should require 150 British thermal units to the boiling point, and then 966 British thermal units would be spent in the evaporation of the 1 lb. of water at 212° ; so that, altogether, the amount of heat required to heat up and change 1 lb. of water from 62° Fahr. into 1 lb. of steam at 212°, under the mean atmospheric pressure of 14·7 lbs. per square inch, is 150 by 966, or 1,116 British thermal units.

Blast-furnace Oil

We shall now calculate the heating value of blast-furnace (coke oven) oil. Two samples of this oil, of specific gravity 920, analysed by Mr. Alfred Allen, of Sheffield, were found to have the following elementary composition :—

	1st Sample.	2nd Sample.	Average.
Carbon	83·380	83·900	83·640
Hydrogen	10·530	10·650	10·590
Sulphur	0·087	0·088	0·0875
Oxygen, &c., by difference......	6·003	5·872	5·9385
	100·000	100·000	100·2560

The oil was further tested by Mr. William Thompson, of Manchester, who estimated its relative calorimetric value by saturating a piece of pumice stone with a known weight of the oil, placing it in the crucible of his water calorimeter, and allowing it to burn slowly in his water calorimeter supplied with oxygen. The burnt products bubbled up through the water, and so raised its temperature. After allowing for loss of heat by radiation, &c., the result obtained for the actual heating or calorimetric value was 16,080 British thermal units, equivalent to an evaporation from and at 212° Fahr. of $\frac{16080}{966}$ or $16\frac{2}{3}$ lb. of water per 1 lb. of oil, provided the whole of the actual heating power was available *above* 212° Fahr., which does not appear to be the case.

In order to calculate this heating value of the oil by our formula, we use the average composition, and have calorimetric value per lb. of fuel = 14,500 (0·8364 + 4·28 × 0·1059) = 18,705 thermal units. Since 1 lb. of hydrogen, when burned, forms 9 lbs. of steam for every pound of oil, the hydrogen 0·1059 lb. will form 0·1059 × 9, or ·9531 lb. of steam. This steam, if not allowed to condense at 212°, and cool to 62° F., will carry off 966 + 150 = 1,116 thermal units per 1 lb., and, therefore, the steam formed, if not condensed, will carry away 0·9531 × 1116 = 1,064 thermal units.

Further, every 1 lb. of carbon forms $3\frac{2}{3}$ lbs. of carbonic acid gas (CO_2), so that for every pound of oil, the 0 8364 lb. of carbon forms 0·8364 × 3·6 = 3·067 lb. of CO_2.

If not cooled below 212° F. to the temperature of cold water, 62° F.—that is, through 150° F.—part of the heat will not be available above 212° F., and must be deducted below 212° F. The specific heat of carbonic acid gas is 0·2164, therefore the quantity of heat lost in not cooling this product below 212° F. is 3·067 × ·2164 × 150 = 99·56, or nearly 100 thermal units.

Thus, for the steam and carbonic acid

formed, we deduct 1,064 + 100 thermal units from the total calorimetric value, 18,705 − 1,164, leaving 17,541 as the first approximation to the effecting heating power above 212° Fahr.

Again, in actual burning of this oil, there must be at least sufficient air introduced to furnish the necessary oxygen for combustion, and, at the same time, the nitrogen of the air comes in with the O, and has to be heated, so that it also takes up part of the heat evolved to raise it above 212° Fahr.

Every 1 lb. of hydrogen requires 34·8 lb. of air, giving 26·8 lb. of nitrogen; so that ·1059 lb. of hydrogen requires 26·8 × 0·1059 = 2·84 lb. of nitrogen; also, every 1 lb. of carbon needs 11·6 lb. air, giving 8·94 lb. nitrogen; then ·8364 lb. carbon needs 8·94 × ·8364 = 7·48 lb. of nitrogen.

Altogether, 2·84 + 7·48 = 10·32 lb. of nitrogen is introduced of specific heat ·244, and raised in temperature from 62° to 212°; that is, 150°; and therefore takes away heat = 10 × ·244 × 150 = 366 thermal units.

Further deducting this quantity of heat from heating value 17,541 − 366, leaving available above 212° Fahr., the effective calorific value = 17,175 thermal units, that is considerably in excess of the actual calorimetric estimation.

In order to calculate the evaporative power, at any given temperature, of the heat of combustion, we must thus deduct from the total calorimetric value, as found by above formula, the total heat that would be evolved by all the products in cooling below that particular temperature to 62° Fahr. Then the remaining available thermal units, divided by the amount necessary to evaporate 1 lb. of water at that temperature, will give the evaporative power, assuming a perfect boiler.

For instance, suppose for the moment that the above effective calorific value, 17,175 thermal units, were available above 281° Fahr., the temperature at which steam is generated, under a pressnre of 50 lb. per square inch, we are given that the total heat required to produce steam at 50 lb. per square inch (at 281° Fahr.) from water at 62° Fahr. is 1,137 thermal units. If the water is supplied at 212° Fahr., then the heat required will be 150 units less, that is, 1,137 − 150 = 987 thermal units.

Therefore, the greatest possible amount of water that could be evaporated with the given effective heat = $\frac{17175}{987}$ = 17·4 lb.

There is always loss of heat in the steam boiler, so let us assume a loss of 30 per cent., efficiency of boiler 70 per cent., that is to say, of the effective heat given by the fuel, the boiler utilises 70 per cent.; then the evaporation comes out 17·4 × 70, or about 12 lb. of steam formed at pressure of 50 lb. per square inch, when feed water is supplied at 212° Fahr. If the boiler efficiency were 75 per cent., then the evaporation would be 17·4 × 75, or 13 lb. of water at 281° Fahr. from 212° Fahr.

As a matter of fact, Dr. Sadler, of Middlesborough, finds, as the result of a large number of trials of creosote oil as fuel in a steam boiler, that 1 lb. of creosote oil evaporates, or converts, 13 lb. of water into steam at 50 lb. per square inch, with water supplied at 212° Fahr. From this we must deduct 5 per cent. of the steam formed, which is used up in supplying steam to the jet of the oil injector, leaving about 12·35 lb. of water evaporated by means of 1 lb. of creosote oil fuel.

In the same boiler he carried out a series of very careful evaporating trials with best Durham steam coal, and the best result obtained was that 1 lb. coal formed 8 lb. of steam, at a pressure of 50 lb. to the square inch, from water supplied at 212°, as compared with over 12 lb. evaporation with creosote under same conditions.

The evaporative power is not alone a sufficient test of the value of a fuel. Liquid fuel has a number of practical advantages in its favour when compared with coal. In fact, a boiler worked with liquid fuel gives fully 10 per cent. more effective power, as there is no clearing or stoking fires, and the firing is uniform and continuous. Whereas, in a boiler fired by hand with coal, the fire doors are continually being opened, admitting cold air. In the case of oil fuel, there is no expense in removing ashes, cleaning of grates, &c. such labour is practically dispensed with. Taking all these advantages into account, Dr. Sadler finds, by experience, that one ton of oil is equal to two tons of coal.

Petroleum Refuse.

In order to compare such calculations with practical results, take the astatki, or petroleum refuse, used by Mr. Urquhart in locomotives in South-east Russia. The chemical composition of petroleum refuse, of specific gravity ·928, is in 1 lb. of oil-carbon ·871, and hydrogen ·117. The calorimetric value per lb. is = 14,500 (0·871 × 4·28 × 0·117) = 19,832 thermal units. For every lb. of oil burned 9, × 0·117 = 1·053 lb. of steam would be formed, which, if not condensed and cooled to 62° Fahr. would

escape and carry off per lb. the latent heat of evaporation at 212°, namely, 966 units, and the heat otherwise evolved in cooling as water, say to 62° Fahr., that is 150 thermals, or a total per lb. of 1,116 thermal units, included in the above calorimetric value. Hence we must deduct from this the heat carried away by the steam $9 \times 0{\cdot}117 \times 1{,}116 = 1{,}175$ thermal units. Neglecting the small loss of heat in the hot carbonic acid formed, also included in the calorimetric value, the effective calorific value of the oil refuse is $19{,}832 - 1{,}175 = 18{,}657$ thermal units. Consequently the evaporative power is $\frac{18657}{966} = 19{\cdot}3$ lb. of water from and at 212° Fahr.

Again, the heat required to form 1 lb. of steam, at pressure of 125 lb. per square inch, from water at 59° or 60° Fahr., is 1,162 thermal units. Therefore, the greatest possible evaporation per lb. of oil refuse under these conditions would be $\frac{18657}{1162} = 16{\cdot}05$ lb. of water. This is with boiler efficiency 100 per cent.

The highest actual evaporation given is 14 lb. per lb. of oil; that is, with a boiler efficiency of 87 per cent., since $16{\cdot}05 \times 87 = 14$.

In ordinary practice, the evaporation of 12½ lb. of water per lb. of oil would indicate a boiler efficiency above 76 per cent.

This calculation can only be very approximate, since the conditions of combustion in the ordinary calorimeter are so very different from the state of things in the combustion chamber of the locomotive.

TABLE VI.—OIL-FUEL.

Locality.	Fuel.	Specific Gravity at 0° C.	Chemical Composition.			Heating power.	
			Carbon.	Hydrogen.	Oxygen.	Actual Calorimetric	Calculated.
Russian	Petroleum refuse	0·928	87·1	11·7	1·2	..	11,018
,,	Astatki	·9	84·94	13·96	1·2	10,340	11,626
Caucasian	Heavy crude	·938	86·6	12·3	1·1	10,800	11,200
,, (Novorossisk)	,, ,,	..	84·9	11·63	1·458	10,328	—
Pennsylvanian	,, ,,	·886	84·9	13·7	1·4	..	10,672
American	,, ,,	..	86·894	13·107	..	10,912	—
,,	Refined	..	85·491	14·216	0·293	11,045	—
,,	Treble refined	..	80·583	15·101	4·316	11,086	—
,,	Crude ,,	..	83·012	13·389	3·099	11,094	—
,,	Solid residuum	..	97·855	0·489	1·196	8,057	—
Scotch	Blast Furnace Oil	·920	83·64	10·59	9·458	10,328	—

Table VI. gives the composition of heavy refuse, suitable for liquid fuel. Although the above examples prove conclusively that 1 lb. of oil fuel can evaporate much more water than 1 lb. of coal, still 1d. worth of oil has not in it the calorific power equal to that of 1d. worth of coal, under ordinary working conditions. Hence, if in this country you have a hydrocarbon produced in the ordinary process of manufacture as a residual product, like "dead oil," then you may use such refuse as a liquid fuel with decided economy.

Advantages of Oil-fuel.

In considering the relative value of two fuels, the evaporative or calorific power must not be taken alone. There are important advantages attending the use of petroleum as fuel, instead of coals, on board ship, which we cannot afford to overlook. Thus there is absence of smoke, the oil fires are completely under control, and more perfect combustion is ensured without hard labour being imposed on human beings called stokers, coal trimmers, and the like. Fire-grates do not need cleaning of clinker as when coal is used. Boiler tubes do not need sweeping so often. Besides, the carrying capacity of ships is reduced for any given power, and any large warship in the fleet is enabled to take liquid fuel aboard easily and quickly at sea without loss. Besides, the absence of coal-dust, ashes, and cinders is very important for the machinery in high speed vessels, as well as for comfort of passengers.

The disadvantages are (1) danger of explosion from inflammable vapour collecting, as in the case of coal dust. The oil-tank ought on no account to be examined by a naked flame or light. It is of vast importance to

have some kind of safety lamp, such as that invented by my colleague, Professor Frank Clowes, D.Sc., by means of which the slightest tendency to an inflammable mixture is immediately detected. (2) Cost of oil compared with coal, and the difficulty of having an assured supply of oil in large quantities at a reasonable price.

[*To be continued.*]

Miscellaneous.

RUSSIAN SALT INDUSTRY.

The following particulars respecting the salt deposits of the Russian Empire and the salt industry in that country are obtained by the *Board of Trade Journal* from the *Viestnik Finançoff*. It is stated that the country possesses sufficient salt, not only for its own use, but for the whole European consumption for many centuries:—

"The annual consumption of salt in Europe, including Russia, is estimated at 5,625,000 tons, and yet a comparatively small section of the Iletz mines—by no means the chief salt mines of Russia—is computed to contain 1,607,000,000 of tons of rock salt. As the principal centres of the industry are situated in the southern and eastern extremities of the empire, where, until recently, there were few transport facilities, Russia had always been compelled to draw her salt, to a certain extent, from abroad; and even now she imports about 16,000 tons annually, although no longer so dependent on foreign supplies since the discovery of rich deposits in Yekaterinburg, the extension of the railway system, and the regulation of tariff rates.

"Since 1818, both the State and private capitalists have been engaged in the salt industry in Russia; in the latter case, the product had to be sold to the State, or else—a fixed duty having been paid—it could be sold without further restriction. In this way arose competition between the State and private enterprise, and the Government, without prohibiting the import of salt, imposed a Customs' duty equivalent to the internal salt tax. It was not till 1862 that the Government saw the wisdom of abandoning such a system, and, retiring from the enterprise, simply levied the tax. As a result, the production of salt rose from 418,000 tons, in 1861, to 723,000 tons in 1862.

"The salt tax brought the Government about 10,000,000 roubles per annum, and in 1881 this was sacrificed, and the Customs' duty also reduced for the benefit of the agricultural, cattle-rearing, and manufacturing communities. As a consequence, the salt consumption rose 80 per cent. between 1881 and 1890.

"The production of rock salt has increased 358 per cent. since 1870; that of lake salt, 240 per cent.; and that of brine salt, 98 per cent. On the whole, the production has increased 192 per cent. within the last 20 years.

"By far the greater part of Russia's salt is obtained from the lakes. The great lowland lying between the Caspian Sea and the Sea of Aral, and which was once the bottom of an immense sea connected with the Arctic Ocean on the north, and the Black Sea on the south, contains several thousands of salt lakes, which, roughly, may be divided into three categories: those formed by the alkalisation of the soil, those formed by inundations, and those fed by salt springs. The richest of the salt lakes is that of Elton, in the government of Astrakhan, and about 93 miles from the Volga, where salt has been produced from the remotest times. This lake is now, however, entirely superseded by Lake Baskounchak, only about 33 miles from the Volga, and more favourably situated for transport purposes. The importance of Baskounchak was much enhanced by its railway connection, in 1882, with the port of Vladimir, on the Volga.

"Of 147,000 tons of salt produced in 1886 in the government of Astrakhan, Lake Elton produced 94,000 tons. At that time Lake Baskounchak was not being worked. In 1870, the same government produced 103,000 tons, of which Lake Elton contributed 16,300 tons only, and Baskounchak 20,600 tons. Ten years later, Elton produced only 8,400 tons, and Lake Baskounchak 162,000 tons, and now the latter yields more salt than any other place in Russia (16 per cent. of the total production), while Lake Elton is no longer worked.

"Lake Baskounchak has an area of 70 square miles, and is dry during the spring and summer months, when the bed is covered with a layer of salt, consisting of various strata, the first of which is from three to four fathoms thick, being, in its turn, made up of strata consisting of salts of various qualities. The best salt is obtained from the third of these latter strata from the top, and is known as *granitka*. The salt of most frequent formation is called *novosadki;* it is softer than, and often preferred to, the *granitka*.

"The lake salts have varieties of colour as well as of hardness. Some salts are snow-white, others bluish, pink, grey, and black. The dearest is the 'snow-white.'

"The lake is divided into 360 allotments, which are farmed out at rates chargeable on every 1,000 pouds of output, and determined by public tender, according to the position of the allotments. The rates vary between 10 and 30 roubles per 1,000 pouds, or one to three copecks the poud.

"The quarrying, &c., is entrusted by the allotment holders to labourers' 'artels.' The average output per man is about 80 or 100 tons for the season (April to October), for which he gets from 7 to 10 roubles, according to the depth from which the salt is obtained.

"The remaining salt lakes of the Aral Caspian low-

land are scattered along the Caspian coast in the government of Sevastopol, the district of Daghestan, Baku, and the Trans-Caspian, Ural, and Tourgai districts. In all these places, however, the salt industry has a purely local significance.

"Like the shores of the Caspian Sea, the northern coast of the Black Sea is studded with salt lakes, which, though not so rich in salt as the lakes in Astrakhan, yet yield a large quantity.

"A greater expenditure of labour and care is here necessary, as artificial basins have often to be constructed to anticipate the exhaustion of the lakes.

"The labour so expended is, however, compensated for by the favourable geographical situation of the salt factories.

"The salt lakes of the Crimea may be divided into five groups: those of Eupatoria, Perekop, Genichesk, Kertch-Theodosian, and Kinburn group, and the lakes in the vicinity of the railway. The lakes of the Eupatorian group belong partly to the State and private capitalists.

"The State lakes are farmed at charges varying between one and four copecks per poud of the output. The most important of them are the Saksk and Sasyk-Sivash lakes which, together, produced 84,100 tons of salt in 1890. The most important of the private lakes is Kamrat, which produced 11,000 tons in that year. The output of the Perekop lakes is only about 8,000 tons. Of the so-called railway lakes, one, extending to the Taganash station of the Lozovo-Sevastopol line, produces 64,300 tons per annum; another, Lake Chongar, about 56,200 tons, and the whole group about 129,000 tons. The Genichesk and the Kertch-Theodosian and Kinburn groups produce together about 7,000,000 pouds, making 377,000 tons for all the Crimean lakes.

"In point of quantity of output, salt from the springs comes next in importance. The brine either flows spontaneously from natural springs or is pumped from artificial wells and borings. Provided cheap fuel is at hand, this branch of the salt industry is very profitable. The government of Perm is in every way adapted for carrying on this branch of industry with success. It was first started here in the reign of the Tsar John, surnamed 'The Stern.' The brine is here pumped from depths varying between 28 and 90 fathoms. During boring operations on the estates of Count Stroganoff, 11 rock-salt beds, averaging each 20 fathoms of thickness, were encountered, the first at a depth of 73 fathoms.

"The production of salt in Perm in 1890 was 289,000 tons, and was obtained from 66 borings and wells. Most of the works are situated along the banks of the Kama, which affords transport facilities in despatching salt and obtaining fuel. The output of the government of Perm has risen from 179,000 tons in 1881 to 289,000 tons in 1890.

"After Perm comes Kharkoff in the production of salt from brine. Donetz coal is here used exclusively as fuel, and only about half a poud (18 lbs.) of coal is consumed in producing a poud of salt, whereas in the Perm salines, owing, no doubt, to the inferior quality of the coal, 32 cwt. of the latter are required in producing 39 to 43 cwt. of salt.

"The chief brine wells of the Kharkoff government are situated near the town of Slaviansk, where, in 1890, there were 21 establishments at work, producing in all 52,000 tons of salt, or 2,475 tons each, as compared with 19,290 tons in Perm.

"The third place of importance for salines is Bachmut, in the government of Yekaterinoslav, where, in 1890, a single factory turned out 28,200 tons of salt.

"Of the total production of salt in 1890, 81 per cent. came from Bachmut in the government of Yekaterinoslav. Other rock-salt beds of Russia are those of Iletz, Erivan, and Kars, the production of the two latter in 1890 being respectively 12,600 tons and 6,350 tons."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 7...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Engineers, Westminster Town-hall, W., 7½ p.m. Mr. W. H. Holttum, "The use of Steel Needles in driving a Tunnel at King's-cross."
Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. "New Method for the Preparation of Nitrous Oxide." 2. Mr. Watson Smith, "Notes on Schurmann's Reactions." 3. Prof. W. Ramsay and Mr. J. C. Chorley, "Distillation of Wood."
British Architects, 9, Conduit-street, W., 8 p.m. The Opening Address, by J. Macvicar Anderson, President.

TUESDAY, Nov. 8...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Address by the President, Mr. Harrison Hayter.
Photographic, 5A, Pall-mall East, S.W., 8 p.m. 1. Address by the President. 2. Mr. Howard Farmer, "Some remarkable properties of Silver and Gelatine."
Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. F. Im Thurn, "Anthropological Uses of the Camera." 2. Mr. H. Ling Roth, "Couvade." 3. Mr. S. E. Peal, "The Morong."
Colonial Inst., Whitehall Rooms, Hotel Metropole, S.W., 8 p.m. Sir Malcolm Fraser, "The Present Condition and Prospects of Western Australia."

WEDNESDAY, Nov. 9...Geological, Burlington-house, W., 8 p.m. 1. Professor M. E. Wadsworth, "A Sketch of the Geology of the Iron, Gold, and Copper Districts of Michigan." 2. Mr. H. M. Becher, "The Gold-quartz Deposits of Pahang (Malay Peninsula)." 3. Mr. F. D. Power, "The Pambula Gold Deposits"

THURSDAY, Nov 10...Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. James Swinburne's paper, "The Problems of Commercial Electrolysis."

FRIDAY, Nov. 11...Astronomical, Burlington-house, W., 8 p.m.
Physical, Science Schools, South Kensington, S.W., 5 p.m. Continued Discussion on the papers by Mr. Williams and Mr. Sutherland, "Dimensions of Physical Quantities," and "Molecular Forces."

SATURDAY, Nov. 12...North-East Coast Institute of Engineers and Shipbuilders, The Athenæum, West Hartlepool, 7½ p.m.
Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, NOVEMBER 11, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-ninth Session of the Society will be held on Wednesday, the 16th November, when the Opening Address will be delivered by Sir RICHARD WEBSTER, Q.C., M.P., Chairman of the Council. Previous to Christmas, there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

ORDINARY MEETINGS.

NOVEMBER 16.—Opening Address by Sir RICHARD WEBSTER, Q.C., M.P., Chairman of the Council.

NOVEMBER 23.—"The Disposal of the Dead." By F. SEYMOUR HADEN, F.R.C.S. DR. G. V. POORE will preside.

NOVEMBER 30.—"The Copper Resources of the United States." By JAMES DOUGLAS.

DECEMBER 7.—"The Chicago Exhibition, 1893." By JAMES DREDGE.

DECEMBER 14.—"The Utilisation of Niagara." By PROF. GEORGE FORBES, F.R.S. SIR RICHARD WEBSTER, Q.C., M.P., will preside.

Papers for which dates have not yet been fixed:—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." By PROF. FRANK CLOWES, D.Sc.

"The Purification of the Air Supply to Public Buildings and Dwellings." By WILLIAM KEY.

"Pottery Glazes: their Classification and Decorative Value in Ceramic Design." By WILTON P. RIX.

"The Chemical Technology of Oil Boiling, with a Description of a New Process for the Preparation of Drying Oils, and an Oil Varnish." By PROF. W. NOEL HARTLEY, F.R.S.

"The Mining Industries of South Africa." By BENNETT H. BROUGH.

"Ten Years of Progress in India." By SIR WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D.

"Australasia as a Field for Anglo-Indian Colonisation." By SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General for Tasmania.

"Indian Manufactures." By SIR JULAND DANVERS, K.C.S.I., late Public Works Secretary, India-office.

"Caste and Occupation at the last Census of India." By JERVOISE ATHELSTANE BAINES, I.C.S., Imperial Census Commissioner for India.

"Mexico, Past and Present." By EDWARD J. HOWELL.

"Newfoundland." By CECIL FANE.

"New Zealand." By W. B. PERCIVAL, Agent-General for New Zealand.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 19; February 16; March 9; April 6, 27; May 11.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 17; February 28; March 21; April 2, 16.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 24; February 7, 21; March 14; April 11; May 9.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

PROF. VIVIAN LEWES, "The Generation of Light from Coal Gas." Four Lectures.

November 21, 28; December 5, 12.

DR. J. A. FLEMING, "The Practical Measurement of Alternating Electric Currents." Four Lectures.

January 30; February 6, 13, 20.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.

March 6, 13, 20.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The

History and Practice of Mosaics." Two Lectures.

May 8, 15.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

January 13, 20, 27; February 3, 10, 17.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 4 and 11, 1893, at 7 p.m.

INDIAN SECTION.

A meeting of the Committee of the Section was held on Tuesday, 8th inst., at 4 p.m. Present:—SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., in the chair, Lionel Ashburner, Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., F. C. Danvers, Walter H. Harris, C. M. Kennedy, C.B., Alexander Rogers, Sir Charles Turner, K.C.I.E., Sir Alexander Wilson, W. Martin Wood, with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, Secretary of he Committee.

The programme of papers to be read during the present Session was discussed.

"OWEN JONES" PRIZES.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in actual competition, produce the best design for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in he present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates:—

Robert Dow, School of Art, Glasgow.—Design for a printed hanging.

Florence Morris, School of Art, Hertford.—Design for a plate.

William Spiers, School of Art, Glasgow.—Design for a hanging.

Ella B. Ginn, School of Art, Hertford.—Design for wall tiles.

Ada Hasleham, School of Art, Cavendish-street, Manchester.—Design for a printed cotton.

Joseph G. Slade, School of Art, Cavendish-street, Manchester.—Design for calico prints.

The next award will be made in 1893, when six prizes will be offered for competition.

Proceedings of the Society.

CANTOR LECTURES.

USES OF PETROLEUM IN PRIME MOVERS.

By PROFESSOR W. ROBINSON, M.E.,
Assoc. M.Inst. C.E., University College, Nottingham.

Lecture IV.—Delivered March 21, 1892.

[*Concluded from p.* 1032.]

OIL STORAGE.

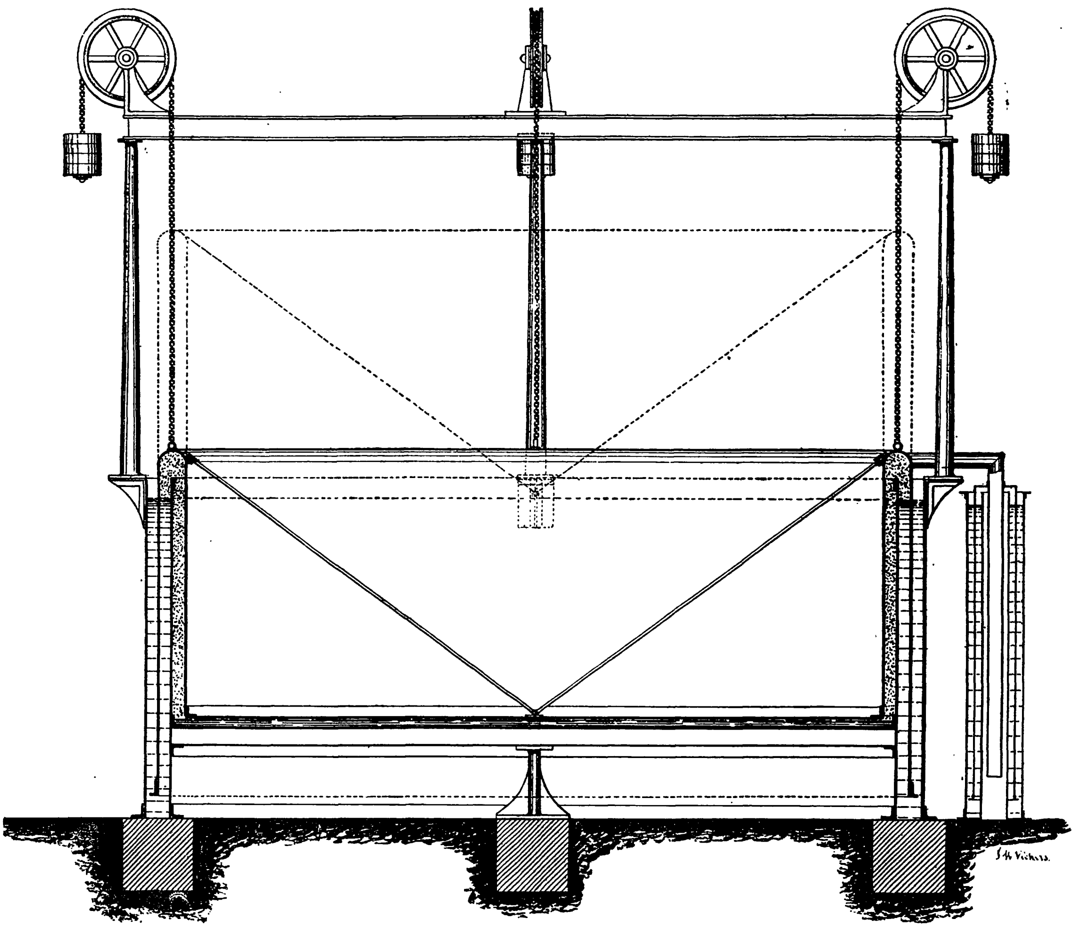
It is highly desirable to be able to store with safety the different petroleum oils. The essential point is to have the oils stored in something like ordinary coal-gas tanks without exposure to the air, because, if exposed to the atmosphere, a small portion of every oil evaporates rapidly, and forms inflammable mixtures with the air above. The model, Fig. 38 (p. 1037), gives you a sectional view of Thwaite's safety oil storage tank. The cover-plate is kept on constantly in contact with the oil and counterbalanced by weights to give the oil only a slight pressure of one or two inches of water. The frame moves into this annular water-seal stand-pipe to the right (Fig. 38), by which any gas that collects may be drawn off by the pipe and utilised. There is no necessity for the introduction of air to empty the tank; the oil is kept cool under very slight pressure, and there is no space left to allow a dangerous explosive mixture to accumulate inside the tank.

Underground tanks built in cement, and

lined with lead or tin, are sometimes employed for storage. This should be surrounded by an embankment, fitted to contain all the oil in case of accident, without allowing any to flow away.

The British Government would do well to establish a proper system of safe oil storage tanks at all the coaling stations. Such storage-tanks would remove one of the difficulties in the way of liquid fuel, and thereby encourage and facilitate the advancement of this important industry, and at the same time secure greater safety to the general public in the use of these oils.

FIG. 38.



OIL STORAGE TANK.—SECTIONAL VIEW.

PETROLEUM AS A LUBRICANT.

The extensive use of mineral oil as a lubricant, including even crude petroleum as well as the suitable distilled products, may perhaps be referred to in considering the uses of petroleum in prime movers. Apart altogether from the use of petroleum as fuel in the cylinder of the Priestman oil-engine, I pointed out to you that the condensed oil-vapour lubricates the cylinder, and contributes to the smooth running of that engine.

Mr. Urquhart gets the pure petroleum refuse by skimming the cream off the oil after settling in the reservoirs, and finds this refuse makes an excellent lubricant for the railway wagons and tenders.

The crude oil is also used for lubrication in the oil-regions of America.

A large variety of mineral lubricating oils are manufactured from the residues left after the lighting-oils at the refineries, by (1) distillation with superheated steam and (2) subsequent chemical purification, including filtration

through animal charcoal to improve their colour and odour.

A serious objection to animal and vegetable oils as lubricants is their tendency to take up oxygen from the air, to become oxidised, causing "gumming" and heating. In this way cotton or woollen waste smeared with these oils, when left exposed to the air, gets heated, and may cause spontaneous ignition, or perhaps a serious fire in a cotton mill. Mineral oils are free from this tendency to oxidise, and when mixed with animal and vegetable oils render these less liable to excite spontaneous combustion.

The function of a lubricant is to keep two sliding or moving surfaces apart, by forming between them a thin film, which reduces the frictional resistance, so that the solid surfaces work together smoothly, thereby preventing undue heating and wear of the working parts, and at the same time effecting a saving in the driving power.

The oil must be thick enough not to be squeezed out from between the surfaces by the greatest working pressure, or at the highest allowable temperature. Different mineral oils are, therefore, selected to suit various purposes. Thus thin oils are suitable for light and delicate working parts, whilst heavy viscous oils, with greater body, as semi-solid lubricants, will do best for heavy machinery.

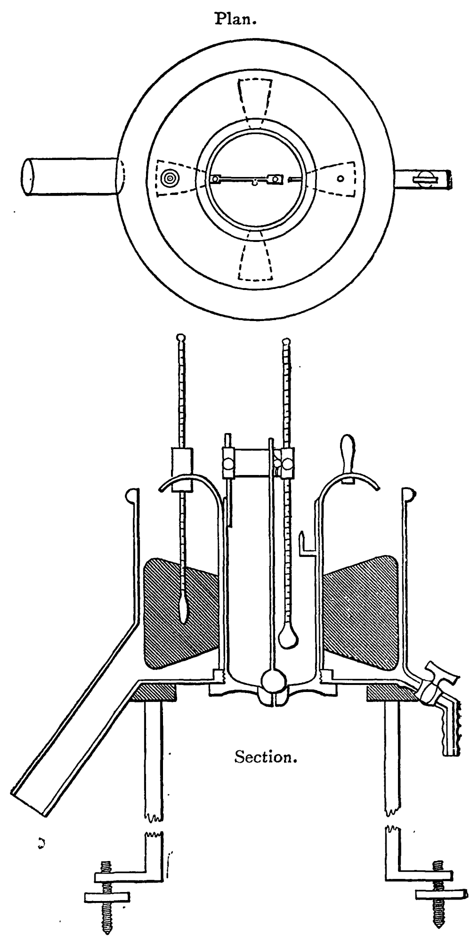
Experience abundantly proves that the frictional resistance does not depend alone upon the true fitting and nature of the solid surfaces, but largely upon the nature of the lubricant that keeps them apart. In fact, the motion is not so much between the solid surfaces as between the particles of the oil or other lubricant. This resistance which a liquid or any fluid offers to sudden change of form, is really a *yielding rigidity* called *viscosity;* and this property of an oil comes most into play for lubricating purposes.

We must, therefore, in every case select an oil of suitable viscosity, at the desired temperature, for the pressure and relative motion between the moving parts. Although the thickest and most viscous oils may suit heavy work and high temperature, it does not follow that they are the best lubricants in every case. After all, experience is the best test of a lubricating oil for any given journal or bearing.

Boverton Redwood's Viscometer.

It appears that there is a relation between the viscosity and lubricating power of an oil, so that, if we find in practice the proper oil for some particular purpose, we may at any future time test the viscosity of a sample, in order to find whether it is the same as the oil previously used. We have here on the table, and Fig. 39 shows a plan and sectional elevation of the standard viscosity meter, or viscometer, devised by Mr. Boverton Redwood, *to measure the viscosity of lubricating oils by the length of time occupied by a given quantity of the oil in flowing through a small orifice at a given temperature.*

Fig. 39.



Boverton Redwood's Viscometer.

The Redwood viscometer (Fig. 39) and its use are thus described:—The instrument consists of a silvered brass oil-cylinder, furnished with an agate jet, and surrounded by a copper bath. A copper tube, closed at the lower end, projecting at an angle of 45° from the side of the bath, near the bottom, provides a means of heating the bath

liquid, and by the use of a revolving agitator, which forms part of the apparatus, the heated liquid rising from the copper tube can be uniformly distributed throughout the bath. The agitator carries a thermometer to indicate the temperature of the bath. The oil-cylinder is furnished with a stopper, consisting of a small brass sphere attached to a wire, the sphere resting in a hemispherical cavity in the agate jet. A short standard, attached to the oil-cylinder, carries a clip to support a thermometer in the oil. Inside the oil-cylinder, and at a short distance from the top, is fixed a small bracket, terminating in an up-turned point, which forms a gauge of the height of the oil-level. The instrument is supported on a tripod stand provided with levelling screws.

Directions for Use.—The jet should be carefully examined before the apparatus is used, and, if necessary, should be cleaned by passing a piece of soft string through it. The apparatus should be adjusted by means of the levelling screws, so that a spirit level placed on the top of the oil-cup shows it to be horizontal.

The bath is filled with a suitable liquid, to a height roughly corresponding with the point of the gauge in the oil-cylinder. Water answers well for temperatures up to 200° F., and for higher temperatures a heavy mineral oil may be used. The liquid, having been brought to the required temperature, the oil to be tested, previously brought to the same temperature, is poured into the oil-cylinder, until the level of the liquid just reaches the point of the gauge. A narrow-necked flask, holding 50 cubic centimetres to a point marked on the neck, is placed beneath the jet in a vessel containing a liquid of the same temperature as the oil. The ball valve is then raised, a stop-watch at the same time started, and the number of seconds occupied in the outflow of 50 c.c. noted. It is of the greatest importance that the oil-cylinder should be filled exactly to the point of the gauge, after inserting the thermometer, and that the given temperature should be precisely maintained during the experiment, a difference of ½° F. making an appreciable alteration in the viscosity of some oils. It is also essential that the oil should be quite free from dirt or other suspended matter, and from globules of water, as the jet may be otherwise partially obstructed. If the oil-cylinder requires to be wiped out, paper rather than cloth should be employed, as filaments of the latter may be left adhering. When oils are being tested at temperatures much above that of the laboratory, a gas flame is applied to the copper heating tube, and the agitator kept in gentle motion throughout the experiment.

Mr. Redwood recommends that the number of seconds occupied in the outflow of 50 cubic centimetres of the oil under examination should be multiplied by 100, and divided by 535 (the number of seconds occupied in the outflow of 50 c.c. of average refined rape oil at 60° Fahr.). The resulting figures should then be multiplied by the specific gravity of the oil under examination at the temperature of the experiment, and divided by 915 (the sp. gr. of refined rape oil at 60° Fahr.); the necessary correction for specific gravity being thus made, the final figures will express the viscosity of the oil, at the temperature of the test, in terms of the viscosity of refined rape oil at 60° Fahr.

$$\text{Viscosity} = \frac{\text{Seconds of flow} \times 100 \times \text{sp. gr. of sample.}}{535 \times 915}$$

Each instrument is carefully standardised, and admits of being employed for the accurate determination of viscosities at temperatures up to 300° Fahr., or even higher.

The oils are usually tested at two points, say 70° Fahr. and 140° Fahr., within which range the oil is likely to be used. The viscosity within these limits of temperature gives you some idea of the "body," or yielding rigidity of the oil, which enables it to keep the metal surfaces apart, and to allow them to move freely. The more viscous an oil, the greater the pressure necessary to squeeze it out from between the moving surfaces. Increase of temperature seriously diminishes the viscosity of an oil, and, therefore, every oil should be tested, if possible, at the temperature it is likely to be used. The variation in the viscosity of different oils, as determined by means of this instrument, is seen by Table VII. (p. 1040), which gives the number of seconds* taken by 50 cubic centimetres of the oil in flowing through the orifice at 60° Fahr.

The viscosity of the mineral lubricating oil should be suited to the usual *temperature* of the journal, at a given *speed* and *pressure* as in practice. Having once found an oil suited to the exact conditions, it is easy to compare new samples.

Besides the determination of the (1) specific gravity, and (2) viscosity, the other physical tests of lubricating oils are (3) effects of heat on nature of lubricants as regards—

* See paper in "Journal of Society of Chemical Industry," vol. v., 1886, p. 128.

TABLE VII.

VISCOSITY.—SECONDS TAKEN BY 50 C.C.

Temperature deg. Fahr.	Refined Rape oil.	Refined Rape oil.	Sperm oil.	Neats-foot oil.	American Mineral oil. sp. gr. ·885	American Mineral oil. sp. gr. ·913	American Mineral oil. sp. gr. ·923	Russian Mineral oil. sp. gr. ·909	Russian Mineral oil. sp. gr. ·915	Russian Mineral oil. sp. gr. ·884 (semi-solid).
50	—	$712\frac{1}{2}$	—	620	145	425	1030	2040	2520	—
60	—	540	177	470	105	$295\frac{1}{2}$	680	1235	1980	—
70	406	405	$136\frac{4}{5}$	366	90	225	485	820	1320	—
80	—	326	113	280	73	171	375	580	900	—
90	—	260	96	$219\frac{1}{4}$	$63\frac{1}{2}$	136	262	426	640	—
100	—	$213\frac{1}{2}$	$80\frac{1}{2}$	$174\frac{3}{4}$	54	111	200	315	440	1015
110	—	169	$70\frac{1}{2}$	$147\frac{2}{5}$	50	$89\frac{1}{2}$	153	226	335	$739\frac{1}{2}$
120	147	147	$60\frac{1}{2}$	126	47	78	126	174	245	531
130	—	$123\frac{1}{2}$	57	112	$44\frac{3}{4}$	$63\frac{1}{2}$	101	$135\frac{1}{2}$	185	$398\frac{1}{2}$
140	106	$105\frac{1}{2}$	$50\frac{3}{4}$	$88\frac{2}{5}$	41	58	82	116	145	$317\frac{1}{2}$
150	—	$95\frac{1}{2}$	49	$75\frac{1}{2}$	$37\frac{1}{2}$	52	$70\frac{1}{2}$	95	115	250
160	—	85	$47\frac{1}{2}$	70	—	46	$63\frac{1}{2}$	$83\frac{1}{2}$	$93\frac{1}{2}$	200
170	—	76	46	62	—	—	58	$70\frac{1}{2}$	$77\frac{1}{2}$	161
180	—	69	$44\frac{1}{2}$	$56\frac{1}{2}$	—	—	$52\frac{1}{2}$	$61\frac{1}{2}$	$67\frac{1}{2}$	$134\frac{1}{2}$
190	—	$64\frac{1}{2}$	43	53	—	—	47	$56\frac{1}{2}$	61	$115\frac{1}{2}$
200	58	$58\frac{1}{2}$	42	$50\frac{2}{5}$	—	—	42	$48\frac{1}{2}$	54	$99\frac{1}{4}$
210	—	54	$40\frac{3}{4}$	$48\frac{1}{2}$	—	—	40	—	—	85
220	—	50	39	47	—	—	38	—	—	77
230	—	$47\frac{1}{4}$	$36\frac{3}{4}$	$45\frac{4}{5}$	—	—	—	—	—	$70\frac{1}{2}$
240	—	$45\frac{1}{2}$	$35\frac{3}{4}$	$44\frac{3}{5}$	—	—	—	—	—	$64\frac{1}{2}$
250	—	$43\frac{1}{4}$	$34\frac{3}{4}$	44	—	—	—	—	—	$59\frac{1}{4}$
260	—	Viscosity slightly above the average.	$33\frac{3}{4}$	$43\frac{1}{2}$	—	—	—	—	—	54
270	—		$32\frac{3}{4}$	43	—	—	—	—	—	$48\frac{1}{2}$
280	—		$31\frac{17}{20}$	$41\frac{1}{2}$	—	—	—	—	—	$46\frac{1}{2}$
290	—		$30\frac{3}{4}$	41	—	—	—	—	—	$44\frac{1}{4}$
300	—		30	38	—	—	—	—	—	$42\frac{3}{5}$
310	—		—	35	—	—	—	—	—	—
320	—		—	$33\frac{4}{5}$	—	—	—	—	—	—

(a) Flashing Point (Abel test), which must never be below 250° Fahr., so that no inflammable vapour is given off at any time in practice.

(b) Fire-Test, by Pensky apparatus. In the fire-test the oil-cup is open, exposed to the air, and the bath heated in a cast-iron vessel. The oil should be heated at the rate of 10° Fahr. per minnte.

(c) Volatility, or loss of weight by evaporation when heated in an air bath, so that there may be no loss in every day working. A good oil must not evaporate more than 5 per cent. in ten hours at 60° Fahr., else the bearing is too much dried, and a gum formed. A mineral oil burns without leaving any residue or deposit.

(d) Cold Test.—The temperature at which the oil becomes cloudy and thickens, ceases to flow in a test tube about $1\frac{5}{8}$ inch in diameter, when cooled by a freezing mixture, and the temperature noted at which crystals of solid paraffin are formed. The oil should remain fluid, or like jelly, but never solid, at the lowest winter temperature. The lower the cold test, the better the oil.

(e) Gumming, or tendency to oxidise on exposure to the air, or when in use, is highly objectionable. A small quantity of the sample is allowed to flow down an inclined plane, and the rate of flow observed. Because of this property animal and vegetable oils are inferior to mineral oils. The gumming is due to oxidation, and the presence of free acid, which also acts on and corrodes the metallic surfaces it is used to lubricate. Hence pure mineral oils are best suited for lubrication of high-pressure steam-engine cylinders and valves, &c. Mixtures of mineral with fixed oils, animal or vegetable, although said to be well adapted

to some kinds of moving surfaces, are to be looked upon with suspicion.

In short, heavy mineral oils are specially valuable for lubrication, because they retain their good properties when heated, and do not thicken and oxidise like fixed oils.

Various machines, such as that of Professor Thurston, have been devised to test the relative value of lubricating oils, by using samples of them in journals, under varying conditions of pressure, speed, and temperature. The results thus obtained are not always satisfactory, since they are sometimes found not to agree with practice under every-day working conditions.

Mineral lubricating oils are now being used on all kinds of spindles and machinery. The manufacture of these lubricants from petroleum has been rapidly increasing for some years, and already we can have mineral oils suitable for every prime mover, reducing the frictional resistance of the moving parts, and thus proving to be a cheap and safe lubricant.

Conclusion.

At the outset I enumerated the different kinds of petroleum available for use in prime movers. Throughout this course of lectures I have endeavoured to show you a special use for every kind of petroleum oil; and that all the oils can be employed advantageously in one way or another in prime-movers.

Hitherto the burning oils have been almost exclusively used for lighting purposes; now the same kerosene oil is burned in the cylinder of the modern petroleum engine, and develops power to drive dynamo-electric machines, which generate electricity for lighting and power purposes, doing so both efficiently and economically. The young oil-engine is growing rapidly in power and numbers, and, being self-contained, is proving a more convenient and economical prime mover than either gas or steam-engines, for small powers at least. The common petroleum oil, used in this engine both as fuel and working agent, is to be had in abundance in many parts of the British dominions, and there is good reason to expect, from the wholesale prices already quoted, that the petroleum industry is rapidly extending into fresh fields, and the production of oil is daily increasing.

Engineers, true to their duty, are directing these great stores or sources of power in Nature to the use and convenience of man. We may then look with confidence to the rapid development of the common oil engine.

Practical utility points to the waste refuse from the oil-field or gas works, and turns even this form of petroleum to good account as liquid fuel.

I have not been able to do justice to this important subject in the limited time at our disposal. However, I trust you now look upon common petroleum as a more useful and less dangerous liquid than is commonly supposed. If I have in any way added to your interest in this subject, or suggested thoughts to anyone who may be working at it, and by that means advanced it somewhat, I shall be fully rewarded for trespassing to such length on your patience.

In conclusion, my thanks are due to the gentlemen who supplied me with engines, apparatus, and diagrams for illustrations, and for assistance in various ways. I wish to thank my students for preparing drawings, and especially Mr. Edward Arnold Medley for his kind and zealous help.

Miscellaneous.

COLLECTION OF MINERALS FOR THE CHICAGO EXHIBITION.

It will be remembered that the Royal Commission for the Chicago Exhibition, anxious to comply with a request made to them by the executive authorities, arranged to include in the British Section a typical collection of economic British minerals, and asked for the co-operation of owners and managers of mines in carrying this proposition into effect. At the close of the Exhibition the collection would, it was decided, be presented to an American museum so that it might have a permanent value, and in order to secure uniformity it was required that the specimens should be of such size that they would lie on trays measuring six inches by four inches. Mr. Bennett Brough, of the School of Mines, Royal College of Science, South Kensington, who has kindly undertaken to receive, classify, and arrange the collection, has received a fair number of specimens. The following are particulars of the more important contributions to the collection.

Mr. A. Forster sends an interesting series of specimens of barytes from Bantry, Ireland, and Mr. G. L. Tottenham a similar series from County Leitrim. Specimens of barytes have also been received from Snailbeach Mine, Shropshire, and from Mawsden Mine, Derbyshire. Messrs. Pike Brothers, of Wareham, Dorset, send a sample of their clay used for the manufacture of fine white earthenware. It is technically known as "blue ball clay," and it is interesting historically to note that this clay was used

by Josiah Wedgwood in 1791. The North Devon Clay Company of Torrington, Devon, send a series of specimens of clay, and a photograph showing the open workings. The clay is cut by one man in a straight line, and then is cut across by a second; a third undercuts with an adze, clearing out the clay in 8-inch cubes. The Coniston Mining Syndicate send a handsome specimen of copper pyrites. Specimens of gypsum have been received from the Sub-Wealden Gypsum Company and from the Vale of Belvoir and Newark Plaster Company. Iron ore is well represented. The Hodbarrow Mining Company, Millom, Cumberland, send some fine specimens of their Hodbarrow red hæmatite ore, carefully selected by Mr. Cedric Vaughan. Red hæmatite has also been received from the Park Iron Mines Company, whilst the Lincolnshire iron ore deposits are represented by a series of specimens from the Midland Company's ironstone mines at Frodingham. These are accompanied by a statement of the results of analyses specially made. Lead ore, from the Mawsden Mine in Derbyshire, has been received from Mr. W. Bowman. Specimens of this ore have also been received from the Snailbeach Mine; the Milwr Mining Company, near Holywell, Flintshire; the Coniston Mining Syndicate, Lancashire; the Rushen Mine, Isle of Man; the East Durren Mine; and the Old Gang Lead Mines, Swaledale. Lastly, the Halkyn Mining Company send a complete series of specimens from their mine near Holywell, probably the richest lead mine in Great Britain. Manganese ore, from Beneult Mine, Rhiw, is contributed by Mr. J. Roberts. Ochre, crude yellow ochre, and pond ochre, has been received from the Cronebane and Tigroney Mining Company, from their mines at Avoca, in County Wicklow. Cornwall is represented by a fine series of tin ores from South Condurrow Mine, carefully selected by Mr. W. Rich. Witherite, a mineral worth about £5 per ton, is included in the contributions from the Snailbeach and Old Gang Mines, and specimens of zinc-blende and calamine have been received from the Mawsden Mine, Derbyshire; from Trecastell Mine, Conway, North Wales; from the Milwr Mining Company; and from the Halkyn Mining Company.

The collection of typical coals is as yet incomplete. Prof. Merivale has kindly promised to select hand specimens of north country coals, and Mr. H. W. Hughes specimens of South Staffordshire coals, whilst the Forest of Dean is already well represented by specimens sent by the Park Iron Mines and Colliery Company. Thanks to the energy of Mr. J. R. W. Eldridge, specimens illustrative of the mining industry of the Wakefield district have been collected by the Wakefield Chamber of Commerce. This collection includes samples of coal from Messrs. J. and J. Charlesworth, Messrs. Terry, Greaves and Co., the Victoria Coal and Coke Co., Limited, and Messrs. J. J. W. Woodhead; whilst alumstone, stone, and lead ore are contributed by Messrs. J. H. Cookson and Son, Mr. J. J. Hulbert, and the North Wales Lead Works, Limited.

Specimens of uranium ore have been promised by Mr. Thomas, and numerous other promises have been received, so that, although there are numerous gaps still to be filled, it appears probable that, thanks to the liberality of mine-owners and managers, a thoroughly typical collection will be got together.

The Royal Commission will be glad to receive from mine-owners, and others interested in mineralogy, contributions of any British minerals of economic importance not referred to in the above list.

EDUCATION AND THE PRESS IN BRITISH INDIA.

In a publication issued by the India-office it is stated that education continues to make progress in India, though the proportion of the total population able to read and write, and the proportion of children of school-going age under instruction are still very small in every province except Burma. The number of schools and colleges in British India increased from 134,710 at the beginning to 138,054 at the end of the year 1890-91, and the total number of scholars rose during the same period from 3,626,390 to 3,682,707. Of this latter number, 313,777, as against 294,457 in the previous year, were girls. It is estimated that in British India 19·3 per cent. of all the boys of school-going age attended school, but for girls of school-going age the per-centage was only 1·8 per cent. The total number of scholars are 11·4 per cent. of all children of school-going age of both sexes. At the five universities which hold examinations, grant degrees, and practically control higher and secondary education throughout India, there were 15,589 undergraduates studying at 136 colleges, among whom 76 were girls. The number of students who gained university degrees were—in arts and sciences, 1,348; in law, 224; in medicine, 78; and in engineering, 108. A large number of students obtained subordinate diplomas in medicine, engineering, and agriculture, who had not passed through the full university course. The number of students who presented themselves for the entrance or matriculation examination at the several examinations was 17,254 boys and 142 girls, out of whom 5,377 boys and 79 girls passed. The number of scholars learning English was 353,515. There were 121 training schools for schoolmasters, and 35 for schoolmistresses; from these institutions 1,892 men and 211 women gained certificates as qualified teachers. The number of technical institutions in British India was returned at 17 medical schools, 25 engineering and surveying schools, 4 schools of art, 71 industrial schools, 3 veterinary, and 2 agricultural schools. The most important technical schools are those maintained at the workshops of the great railways. The year showed an increase in the number of scholars of all creeds except Mohammedan; the total number of

Moslem scholars decreased from 854,498 in the previous year to 836,389; among other classes of scholars there were 2,512,916 Hindoos, 25,568 Europeans and Eurasians, and 86,314 native Christians. The total expenditure on education during the year was Rx.2,888,000 as compared with Rx.2,766,000 in the preceding year. During the year 1890-91 there were 573 newspapers and periodicals published in 16 different languages of India. The largest circulation of any daily journal was returned at 1,500, and of any weekly at 20,000 copies. The former was the Guzerathi *Samachar*, and the latter was the Bengali *Bangabusi*. There was no censorship on any of these journals and no restriction beyond the general law against libel, against indecency, and against exciting sedition; but abstracts of articles and intelligence in vernacular newspapers are laid every week before the local and supreme Governments. The total number of books and publications registered during the year was 7,658, or 22 per cent. below the number of the preceding year; about 92 per cent. of these were in vernacular languages, and many were republications or new editions of old works. The subject of the greater number of these works fell under the heads of language and school books, religion, poetry, drama, and fiction.

General Notes.

CIGARETTES IN MEXICO.—The *Mexican Financial Review* says that the manufacture of cigarettes by hand in the city of Mexico has increased enormously in the last five years, notwithstanding the fact that several machines have been invented for making them. There are 3,000 persons, mostly women, employed in the manufacture of cigarettes, and the average produced by each person is 2,000 per day, or a daily total of 6,000,000, equal to 1,728,000,000 cigarettes a year. The average price paid to the operatives is 20 cents per thousand, which is equivalent to 1,200 dollars daily wages, or 345,000 dollars per annum distributed among the 3,000 operatives. The number of working days in a year, exclusive of Sundays and holidays, is 288. These figures refer only to the cigarettes made by hand in the city of Mexico, he statistics as to those made by machinery not being available, and in addition very large quantities of cigarettes are imported from Havana.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 14...Royal Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Opening Address by the President, Mr. Alexander Leslie.

Surveyors, 12, George-street, S.W., 8 p.m. Opening Address by the President, Mr. Charles J. Shoppee.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. Fridtjof Nansen, "On his proposed Expedition across the North Polar Region."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Sir Robert Ball, "Auriga" (illustrated).

TUESDAY, Nov. 15...Society of Architects, St. James'-hall, Piccadilly, W., 3 p.m. Opening Address by the President, Mr. Robert Walker.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Hon. R. C. Parsons, "Halifax Graving-Dock, Nova Scotia." 2. Mr. E. W. Young, "Cockatoo Island Graving-Dock, New South Wales." 3. Mr. W. Redfern Kelly, "The Alexandra Graving-Dock, Belfast." 4. Mr. Robert Pickwell, "Construction of a Concrete Graving Dock at Newport, Monmouthshire."

Statistical, Museum of Practical Geology, 28, Jermyn-street, S.W., 7¾ p.m. Inaugural Address by the President, Mr. Charles Booth.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Messrs. W. Bateson and H. H. Brindley, "Some cases of Variation in Secondary Sexual Characters statistically examined." 2. Mr. G. A. Boulenger, "*Testudo grandidieri*, a new Fossil Giant Tortoise from a Cave in South-west Madagascar." 3. Mr. O. Thomas, "Description of a new Monkey of the Genus *Semnopithecus* from Northern Borneo."

WEDNESDAY, Nov. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the Session. Inaugural Address by Sir Richard Webster, Chairman of the Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. John Lovel, "Thunderstorm, Cloud-burst, and Flood at Langtoft, East Yorkshire, July 3rd, 1892" 2. Mr. W. H. Dines, "The measurement of the maximum Wind Pressure, and Description of a new Instrument for indicating and recording the maximum."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. F. Chapman, "Foraminifera of the Gault of Folkestone." 2. Mr. C. Haughton Gill, "Fungoid growths on Diatoms." 3. Mr. John Hood, "*Notops ruber*, a new rotifer."

THURSDAY, Nov. 17...Linnean, Burlington-house, W., 8 p.m. 1. Rev. Prof. Henslow, "A Theoretical Origin of Endogens through an Aquatic Habit." 2. Mr. G. Lewis, "The Buprestidæ of Japan and their Coloration."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Thorpe and Mr. William Kirman, "Fluosulphonic Acid." 2. Prof. Thorpe and Mr. George H. Perry, "The Interaction of Iodine and Potassium Chlorate." 3. Mr. W. H. Perkin, "Magnetic Rotation of Sulphuric and Nitric Acids, and their Solutions; also of Solutions of Sodium Sulphate and Lithum Nitrate." 4. Mr. S. U. Pickering, "Note on the Refractive Indices and Magnetic Rotation of Sulphuric Acid Solutions." 5. Mr. S. U. Pickering, "Hydrates of Alkylamines." 6. Prof. Ramsay and Miss Emily Aston, "The Atomic Weight of Boron," and other papers.

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon Edmund Venables, "Lincoln Cathedral."

Historical, 20, Hanover-square, W., 8½ p.m. Prof. Julius von Pflugk-Harttung, "The Druids of Ireland."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &c.

American Academy of Arts and Sciences, Proceedings and Memoirs.
American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings.
American Society of Civil Engineers, Transactions and Proceedings.
Association of Engineering Societies, Journal.
Bath and West Southern Counties Society, Journal.
Berlin, Polytechnische Gesellschaft, Polytechnisches Centralblatt.
Birmingham Philosophical Society, Proceedings.
British Association for the Advancement of Science, Report.
British Guiana, Royal Agricultural and Commercial Society of, Journal.
British Horological Institute, Horological Journal.
Camera Club, Journal.
Canada, Royal Society of, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Proceedings.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
Doubs, Société d'Emulation du, Mémoires.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
Incorporated Gas Institute, Transactions.
India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institute of Brewing, Transactions.
Institute of Patent Agents, Transactions.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Jamaica, Institute of, Journal.
Japan, College of Science, Imperial University, Journal.
Junior Engineering Society, Publications.
Kew Gardens Bulletin.
Linnæan Society, Journal.
Liverpool Polytechnic Society, Journal.
London Association of Foremen Engineers and Draughtsmen, Publications.
London Chamber of Commerce, Journal.
Lyon, Société des Sciences Industrielles, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Manitoba Historical and Scientific Society, Papers.
Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Indian Association, "The Indian Magazine."
Nederlandsche Maatschappij ter Bevordering van Nijverheid, Tidjschrift.
New South Wales, Royal Society, Journal and Proceedings.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Natural Science, Proceedings and Transactions.
Paris, Société de Geographie Commerciale, Bulletin.
Patent-office, Illustrated Official Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia, Academy of Natural Sciences, Proceedings.
———, Engineers' Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, Proceedings and Journal.
Royal Geological Society of Ireland, Journal.
Royal Historical and Archæological Association of Ireland, Journal.
Royal Institute of British Architects, Journal of Proceedings and Transactions.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.

Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Transactions.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Internationale des Electriciens, Bulletin.
Société Nationale d'Acclimatation de France, Revue.
Society of Antiquaries, Archæologia and Proceedings.
Society of Architects, Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Cymmrodorion, Magazine.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Tasmania, Royal Society of, Papers and Proceedings.
Victoria Institute, Journal of the Transactions.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Accountant.
Amateur Photographer.
American Economist.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Builders' Weekly Reporter.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Civil Service Competitor.
Colliery Guardian.
Colonies and India.
Cosmos; Revue des Sciences.
Discovery.
Electrical Engineer.
Electrical Review.
Electrician.
Electricien.
Electricité.
Engineer.
Engineer and Iron Trades Advertiser.
Engineering.
Engineering Record (New York).
English Mechanic.
European Mail.
Farmer and Stock Breeder.
Gardeners' Chronicle.
Gardening World.
Herapath's Railway Journal.
Industries.
Invention.
Iron.
Iron and Coal Trades Review.
Ironmonger.
Jewelers' Weekly (New York).
Journal of Gas Lighting.
Journal d'Hygiène.
Journal des Mines.
Land and Water.
Lighthouse.
Medical Press and Circular.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Perak Government Gazette.
Photographic News.
Photographic Work.
Pottery and Glassware Reporter (Pittsburgh
Practical Engineer.
Produce Markets' Review.
Publishers' Circular.
Queen.
Revue Industrielle.
School Board Chronicle.
Schoolmaster.
Science (New York).
Scientific American.
Statist.
Surveyor.
Transport.
Textile Mercury.
Warehousemen and Drapers' Trade Journal.
Whitehall Review.

Fortnightly.

Anthony's Photographic Bulletin.
Brewers' Guardian.
Corps Gras Industriels.
Country Brewers' Gazette.
Finance Chronicle.
Gaçeta Industrial.
Ingeniero y Ferretero Espanol y Sud-Americano.

Irish Builder.
Jeweller and Metalworker.
Moniteur des Produits Chimiques.

Monthly.

Art Journal.
Bookseller.
Brewers' Journal.
British Trade Journal.
Building Societies' Gazette.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette.
Cigar and Tobacco World.
Confectioners' Union.
Dental Record.
Drinks.
Dyer and Calico Printer.
Educational Times.
Educational Review.
Electrical Plant.
Engineering Magazine (New York).
Furniture Gazette.
Furniture and Decoration.
Giornale del Genio Civile.
Hardware Trade Journal.
Inland Architect (Chicago).
Irish Textile Journal.
Ironmongery.
Leather Trades' Circular.
Machinery Market.
Manufacturer and Inventor.
Manufacturers' Review and Industrial Record.
Marine Engineer.
Midland Naturalist.
Mineral Water Trade Review and Guardian.
Moniteur Scientifique.
Musical Times.
Nautical Magazine.
Oestereichische Monatsschrift für den Orient.
Paper Maker.
Paper Makers' Monthly Trade Journal.
Plumber and Decorator.
Pottery Gazette.
Propriété Industrielle.
Railway Engineer.
Railway Press.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sanitary Record.
Sugar Cane.
Specialities.
Symons's Monthly Meteorological Magazine.
Textile Recorder.
Ulster Agriculturist.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Anglo-American Times.
Bombay Gazette (Overland Summary).
Ceylon Observer (Overland Edition).
Daily Inter Ocean (Chicago).
Home and Colonial Mail.
Local Government Journal.
London Commercial Record.
London and China Telegraph.
Madagascar News.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Shipping Gazette and Lloyd's List (Weekly Summary).
South African Empire.
Times of Ceylon (Weekly Summary).
Times of India (Overland Weekly Edition).
West London Observer.

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Society for the Encouragement of Arts, Manufactures, and Commerce,

JOHN STREET, ADELPHI, LONDON, W.C.

EXAMINATIONS, APRIL, 1892.

PRIZES AND CERTIFICATES AWARDED TO CANDIDATES.

PRIZES.

The Society's Bronze Medal has been awarded to the following candidates:—

Arithmetic	James Topping, 24, assistant schoolmaster, Harris Institute, Preston. Arthur Lewis Solomon, 22, clerk—City of London College, E.C.
English	Mary Emily Whittle, 28, governess—School Board, Manchester. Alexandrina Stewart, 23, teacher — Robert Gordon's College, Aberdeen.
Book-keeping..	Arthur Bardsley, 20, clerk—Mechanics' Institution, Burnley. Joseph Lees, 24, clerk—School Board, Manchester. Edward Hart, 18, clerk—Metropolitan School of Shorthand, London, W.C.
Commercial Geography	Alexander Hood Begg, 26, clerk—Athenæum, Glasgow.
Shorthand	Henry William Waller, 17, solicitor's clerk—Metropolitan School of Shorthand, London, W.C. Philip H. Gardner, 20, shorthand clerk—Metropolitan School of Shorthand, London, W.C. George Thomas Higgs, 22, shorthand clerk—Metropolitan School of Shorthand, London, W.C.
Type-writing	Tamar Ann Howard, 36, typist—Metropolitan School of Shorthand, London, W.C.
French	James Lockey, 57, tutor—Birkbeck Literary and Scientific Institution, London, E.C. Robert Munro Lees, 26, clerk—Athenæum, Glasgow.
German	Ernest Richard Morgan, 33, clerk—City of London College, E.C. Hermann Josephy, 20, merchant—Yorkshire College, Leeds.
Italian	Ada McQuade, 24, no occupation—Technical School, Manchester.
Spanish	David Bowman, 23, clerk—Birkbeck Literary and Scientific Institution, London, E.C.
Portuguese	Alfred Calvert, 33, clerk,—School Board, Manchester.
Russian .. .. Danish .. .. Chinese .. .. Japanese..	*No candidates were examined in these subjects.*
Domestic Economy ..	Clara Elizabeth Ruston, 26, teacher—Free Library, Wolverhampton. Lucie McCulloch, 16, pupil—Alexandra College, Shirley, Southampton.
Theory of Music	*No candidate was considered by the Examiner as eligible for a Medal.*

The Prizes offered by the Council of the Society out of the funds which have been placed at their disposal for the purpose by the Worshipful Companies of Goldsmiths, Mercers, Skinners, and Salters, have been awarded as follows:—

English	1st prize of £3	Mary Emily Whittle, 28, governess—School Board, Manchester.
,, ...	2nd prize of £2....	Alexandrina Stewart, 23, teacher — Robert Gordon's College, Aberdeen.
Commercial Geography..	1st prize of £3	Alexander Hood Begg, 26, clerk—Athenæum, Glasgow.
,, ,, ..	2nd prize of £2 ...	John Gordon, 32, cashier—Athenæum, Glasgow.
French	1st prize of £3	James Lockey, 57, tutor—Birkbeck Literary and Scientific Institution, London, E.C.
,, ...	2nd prize of £2	Robert Munro Lees, 26, clerk—Athenæum, Glasgow.
German	1st prize of £3 ...	Ernest Richard Morgan, 33, clerk—City of London College, E.C.
,, ...	2nd prize of £2....	Hermann Josephy, 20, merchant—Yorkshire College, Leeds.
Portuguese*...........	1st prize of £3	Alfred Calvert, 33, clerk — School Board, Manchester.

* *The Second Prize in this subject was not awarded.*

The Prizes offered by the Worshipful Company of Clothworkers have been awarded as follows:—

Italian..................	1st prize of £5	Ada McQuade, 24, no occupation—Technical School, Manchester.
,, ...	2nd prize of £3....	David Clegg, 22, clerk—Technical School, Manchester.
,, ...	3rd prize of £2....	Oswald Adolphus Korth, 36, private tutor—Llanelly.
Spanish	1st prize of £5	David Bowman, 23, clerk—Birkbeck Literary and Scientific Institution, London, E.C.
,, ...	2nd prize of £3....	Walter Floweth, 24, clerk—School Board, Manchester.
,, ...	3rd prize of £2....	Hermann Josephy, 20, merchant—Yorkshire College, Leeds.

CERTIFICATES.

ABERDEEN (CIVIL SERVICE AND BUSINESS COLLEGE).

Allan, Charles, 21, student—Arithmetic (2d)
Chalmers, George, 19, student—Arithmetic (2d)
Farquharson, William, 20, clerk—Arithmetic (3d); Book-keeping (2d)
McDonald, George, 20, student—Book-keeping (2d)
Rattray, James, 22, shop assistant—Book-keeping (2d)
Russell, John, 19, student—Arithmetic (3d)
Smith, W. D., 18, civil service student—Arithmetic (3d)
Stevenson, Hugh, 19 (no occupation stated)—Book-keeping (3d)
Thomson, William James, 18, student—Arithmetic (3d); Book-keeping (2d)

ABERDEEN (MUSIC SCHOOL).

Alexander, Alice M. S., 18, student—Theory of Music (3d)
Cameron, Frances, 15, scholar—Theory of Music (3d)
Croll, Annabella Argo, 16, scholar—Theory of Music (3d)
Davidson, Robert, 27, plumber — Theory of Music (3d)
Ellis, Maggie Cumming, 21, teacher of music —Theory of Music (3d)
Florence, Arthur Petrie, 23, assistant iron-monger—Theory of Music (3d)
Grant, Nellie Ligertwood, 17, student—Theory of Music (3d)
Guthrie, Catherine Isabella Hay, 17, scholar —Theory of Music (3d)

McDermont, Jeannie, 16, student—Theory of Music (2d)
McEwan, Alexander, 28, gilder—Theory of Music (3d)
Macphail, Mary Anna, 14, scholar—Theory of Music (3d)
Matthews, Margaret Fiddes, 16, scholar—Theory of Music (3d)
Matthews, Mary Michie, 18, student—Theory of Music (2d)
Mortimer, Alice Helen, 16, student—Theory of Music (2d)
Rankine, Amelia, 20, student — Theory of Music (3d)
Robb, James John, 25, gilder—Theory of Music (2d)
Ross, Beatrice, 18, teacher of music—Theory of Music (3d)
Ross, Isabella, 21, teacher of music—Theory of Music (2d)
Sangster, Mary C. M., 13, scholar—Theory of Music (3d)
Thompson, Catherine Ella Beatrice, 16, scholar—Theory of Music (3d)
Watson, Alice, 15, scholar—Theory of Music (3d)
Webster, Madge, 16, scholar—Theory of Music (3d)
Wyness, Mary, 19, student—Theory of Music (3d)
Youngson, George, 25, clerk—Theory of Music (3d)
Yule, Susan, 14, scholar—Theory of Music (3d)

ABERDEEN (ROBERT GORDON'S COLLEGE).

Adam, John, 19, cashier—German (3d)
Allan, Alexander Stuart, 18, clerk—Shorthand (3d)
Allan, Isabella Morrison, 16 (no occupation stated)—English (2d)
Allan, Maggie Jane, 19, factory worker—Book-keeping (3d)
Anderson, James Murray, 21, clerk—Book-keeping (3d); Shorthand (3d)
Angus, Bella W., 20, pupil teacher—English (1st)
Bain, William, 32, clerk—Book-keeping (3d)
Bishop, Roderick, 34, fancy box maker—Theory of Music (1st)
Burnett, Bella, 22, drapery assistant—English (2d)
Burnett, James, 14, apprentice mason—English (2d)
Chrystal, Maggie Ramsay, 15, student—Book-keeping (2d)
Craig, John, 29, teacher—German (1st)
Croll, George, 19 (no occupation stated)—Book-keeping (2d)
Donaldson, Kate McPherson, 16, pupil teacher—English (2d)
Emslie, James D., 15, clerk—Theory of Music (3d)
Forbes, Margaret Maria, 21, teacher of music —Theory of Music (1st)
Garden, Emmeline, 19, type-writer — Type-writing (3d)
Gillan, Jeannie Tough, 18, type-writer—Type-writing (2d)
Grant, Robert Martin, 18, clerk—Book-keeping (2d)
Hannan, William, 15, clerk—Shorthand (2d)
Henderson, David, 17, clerk—Shorthand (3d)
Horne, John R., 21, clerk—Book-keeping (3d)
Ironside, Georgina, 15, student—Book-keeping (2d)
Jamieson, Alexandrina, 18 (no occupation) —Shorthand (3d)
Johnston, Joseph James, 21, law apprentice—English (3d)
Kemp, Frank, 19, clerk—Book-keeping (1st)
Knight, James, 18, clerk—Shorthand (3d)
Laing, James, 20, clerk—Arithmetic (3d); English (3d)
Laing, John Gordon, 18, scholar—English (2d)
Levie, George Elder, 19, clerk—Book-keeping (1st)
McBeath, William, 23, factory manager—German (1st)
Mackinnon, Alexander Colin, 20, clerk—English (2d)
Middleton, Charles, 17, clerk—Book-keeping (2d)
Milne, Mary, 16 (no occupation stated)—Theory of Music (2d)
Mitchell, Barbara, 19 (no occupation stated) —English (2d)
Morrison, Eliza, 19 (no occupation stated)—English (3d)
Murray, James W., 24, ironmongers' assistant —Book-keeping (2d)
Nicol, James A., 25, clerk—Book-keeping (3d)
Quin, John, 19, clerk—Book-keeping (2d)
Rennie, George, 19, pupil teacher—English (2d)
Reid, J. Henry, 19, book-keeper—Theory of Music (3d)
Ritchie, Geo. Kilgour, 16, clerk—Book-keeping (3d)
Ross, William, 25, teacher—French (1st)
Scott, Elizabeth, 22, teacher—German (2d)
Simpson, James, 20, clerk—Book-keeping (3d)
Smith, Eva, 18 (no occupation stated)—Theory of Music (3d)
Smith, James, 20, clerk—Shorthand (3d)
Smith, Lizzie Agnes Macdonald, 18 (no occupation)—English (3d)
Stephen, Charles M., 16, musician—Theory of Music (1st)
Stephen, Mary, 14, student—Book-keeping (3d)
Stevenson, Jas. C., 18, railway clerk—Theory of Music (2d)
Stewart, Alexandrina, 23, teacher—English (1st), the Society's Bronze Medal, and the City Companies' Second Prize of £2
Still, William M., 16, clerk—Book-keeping (3d)
Strachan, Charles, 17, woollen warehouseman —Book-keeping (3d)
Taylor, James, 18, clerk—Book-keeping (2d)
Thomson, Elizabeth, 14, student—Book-keeping (3d)
Watts, James Murrian, 19, clerk—Book-keeping (3d)
Wilson, Alexander, 15, ironmonger—Book-keeping (3d)
Wilson, Henry, 19, clerk—Book-keeping (1st)

Wood, John, 18, clerk—Shorthand (3d)
Young, Jeannie G. A., 15, student—Theory of Music (3d)

ABERTILLERY (SCIENCE AND ART CLASSES).

Bailey, Lewis David, 21, teacher—Theory of Music (3d)
Brace, John George, 16, collier—Theory of Music (3d)
Brown, Stephen James, 20, miner—Theory of Music (3d)
Coslett, John H., 19, tin worker—Theory of Music (3d)
Griffiths, Mary E., 10 (no occupation stated)—Theory of Music (3d)
Handy, Charles Joseph, 18, collier—Theory of Music (3d)
James, David Henry, 19, collier—Theory of Music (2d)
Prosser, Herbert Daniel, 22, tin-plate worker—Theory of Music (3d)

BELFAST (SCHOOL OF COMMERCE).

Henderson, John F., 26, clerk—Book-keeping (3d)
Johnston, John Stanley, 16, student—Book-keeping (2d)
Mann, William Henry, 20, bank clerk—Book-keeping (2d)
Olley, Alfred, 21, clerk—Book-keeping (3d)
Ross, Alexander, 14, student—Book-keeping (3d)
Smith, Charles Edward, 25, student—Book-keeping (3d)

BIRMINGHAM AND MIDLAND INSTITUTE.

Allan, Saywell Louis, 30, foreign correspondent—French (2d)
Blaen, John, 28, clerk—Spanish (2d)
Bowler, John Edward, 20, clerk—Theory of Music (2d)
Bright, William Edgar, 28, commercial clerk—German (1st)
Bull, Hubert William, 25, engineer—Spanish (3d)
Burgess, Harry Herbert, 23, house agent—Theory of Music (1st)
Butcher, Lilian, 16 (no occupation)—Theory of Music (3d)
Button, Alfred Ernest, 20, clerk—German (3d)
Corfield, Alice Gertrude, 18 (no occupation)—Arithmetic (3d)
Couch, William Henry 25, clerk—French (3d)
Coy, J. H., 22, oliver smith—Theory of Music (3d)
Deacon, Honley, 21, clerk—German (2d)
Eaton, Rose Iona, 37, teacher of music—French (3d)
Edwards, Florence, 19 (no occupation)—Theory of Music (3d)
Ellis, Henry, 17, clerk—German (3d)
Ellis, Henry Ernest, 27, accountant's clerk—Shorthand (3d)
Field, John, 24, clerk—German (2d)
Fielding, W. E., 19, engineer's clerk—German (3d)
Garbutt, William Henry, 36, reporter—Theory of Music (2d)
Gilburt, Henry, 31, warehouseman—Arithmetic (3d)
Greenwood, Thomas Lewis, 26, book-keeper—Book-keeping (1st)
Harding, Adelaide Mary, 30, governess—French (3d)
Hemming, Charles, 22, electro-plate worker—Theory of Music (3d)
Hill, William Marsh, 38, clerk—Book-keeping (1st)
Hopkins, James Frederick, 15, clerk—Theory of Music (3d)
Incledon, Arthur Kingsley, 21, clerk—Spanish (2d)
Jessop, James Alexander, 23, clerk—French (3d)
Kempson, Lizzie, 22, teacher of pianoforte—Theory of Music (2d)
Kinkelin, Gertrud, 17, student—German (1st)
Mabbutt, Edith Sara, 13 (no occupation stated)—Theory of Music (3d)
Martin, Alice Amelia, 15 (no occupation stated)—Theory of Music (3d)
Miners, Bernard Perry, M.A., 33, bank clerk—French (2d)
Morgan, Lilla, 27, teacher—Theory of Music (2d)
Mullen, Thomas, 38, police sergeant—Italian (3d)
North, Frederick, 27, clerk—German (1st)
Pearson, Lacy Joseph, 31, accountant's clerk—Book-keeping (3d)
Perks, Alice, 14, electro-plate burnisher—Theory of Music (3d)
Priest, Caroline Edith, 30 (no occupation stated)—Theory of Music (2d)
Roberts, Hannah, 14, scholar—Theory of Music (3d)
Rodgers, Herbert James, 17, apprentice—Spanish (3d)
Rooke, Arthur William, 19, accountant's clerk—Book-keeping (3d)
Roper, James, 22, clerk—Spanish (2d)
Rowe, Emily French, 20 (no occupation stated)—Theory of Music (2d)
Shimwell, Henry, 28, clerk—German (1st)
Stanton, Harry Vincent, 22, clerk—Spanish (2d)
Walkley, Charles Ferguson, 22, clerk—Spanish (2d)
Watkins, Ernest Edward, 13, student—Theory of Music (3d)
Webb, Arthur E., 23, clerk—Spanish (2d)
White, Helen, 33, governess—Theory of Music (3d)
Williams, William, 12, scholar—Theory of Music (3d)
Wood, William, 33, cashier—Book-keeping (3d)

BOLTON (CHURCH INSTITUTE).

Bagshaw, Edith Mary, 16, scholar—Book-keeping (3d)
Booth, Fred., 17, junior clerk—Shorthand (3d); Book-keeping (3d)
Booth, Thomas, 16, clerk—Book-keeping (1st)
Dawson, Charles Hollows, 15, scholar—Shorthand (3d)

Dickinson, Samuel, 18, wheelwright—Book-keeping (3d)
Graham Arthur, 20, bank clerk—Book-keeping (1st)
Greenhalgh, George Peter, 19, assistant—Theory of Music (2d)
Halton, Percy H. H., 17, delivery clerk—Book-keeping (2d)
Higson, Henrietta, 16, scholar—Book-keeping (3d)
Hutchinson, George, 21, boot-maker—Theory of Music (3d)
Lever, Percy Fogg, 13, scholar—Shorthand (3d); Theory of Music (3d)
Lord, Ashworth Hargreaves, 19, clerk—Book-keeping (3d); Shorthand (3d); Type-writing (3d)
Lord, Herbert, 18, clerk—Shorthand (3d)
Pilkington, Thomas, 16, railway clerk—Book-keeping (3d)
Potter, George Henry, 18, clerk—Shorthand (2d)
Sharman, Mary, 19, pupil teacher—Book-keeping (2d)
Stott, Alice Elizabeth, 17, scholar—Book-keeping (3d)
Unsworth, Richard, 16, scholar—Theory of Music (2d)
Woodhouse, Percy, 18, bank clerk—Book-keeping (3d)

BOOTLE (TECHNICAL SCHOOL).

Bingham, Charlotte R., 21 (no occupation)—Book-keeping (2d)
Blundell, Harry James, 25, accountant—Book-keeping (3d)
Chick, Henry James, 14, office-boy—Book-keeping (3d)
Cowley, Herbert E., 21, clerk—Book-keeping (3d)
Cushing, Stephen S., 23, book-keeper—Book-keeping (2d)
Fallows, Joseph, 27, store-keeper and book-keeper—Book-keeping (2d)
George, William, 17, clerk—Book-keeping (2d)
Green, William Henry, 16, scholar—Book-keeping (2d)
Heathcott, George H., 23, clerk—Book-keeping (2d)
Hughes, William Ellis, 56, estate agent—Book-keeping (2d)
Jones, Thomas Alfred, 17, clerk — Book-keeping (2d)
Leighton, John H., 25, cashier—Book-keeping (3d)
Morris, Robert, 18, junior clerk—Book-keeping (2d)
Owens, Owen, 16, junior clerk—Book-keeping (2d)
Pheysey, Harold Ree, 22, clerk — Book-keeping (1st)
Reed, Peter, 17, clerk—Book-keeping (1st)
Roberts, William Henry, 15, scholar—Book-keeping (2d)
Rogers, Alfred Ernest, 18, junior clerk—Book-keeping (1st)
Ross, Alexander, 18, clerk—Book-keeping (2d)
Smith, Frank James, 14, scholar—Book-keeping (3d)
Sutcliffe, Sam, 32, grocer's manager—Book-keeping (3d)
Upton, Edwin, 19, accountant's clerk—Book-keeping (2d)
Williams, Harold E., 18, clerk—Book-keeping (2d)
Woodward, Blake, 20, clerk—Book-keeping (3d)

BRADFORD (SCHOOL OF SHORT-HAND).

Barratt, Frederick Wallace, 25, clerk—Shorthand (2d)
Brown, Arthur, 28, clerk—Shorthand (2d)
Brown, Baldwin, 15 (no occupation)—Shorthand (3d)
Drake, Florence, 22 (no occupation)—Shorthand (3d)
Firth, Annie Oliver, 16, type-writer—Shorthand (3d)
Holmes, Wilson T., 24, clerk—Shorthand (2d)
Huntly, Albert, 21, dry goods—Shorthand (3d)
Illingworth, Albert, 26, warehouseman—Shorthand (2d)
Laycock, Ben L., 18, clerk—Shorthand (2d)
Rawson, John Wm., 19, clerk—Shorthand (3d)
Sowden, Charles Ellis, 17, clerk—Shorthand (2d)
Smith, John William, 23, clerk—Shorthand (2d)
Spenser, Norcliffe, 21, articled clerk—Book-keeping (1st)
Sutcliffe, Gertrude, 13, scholar—Shorthand (3d)

BRADFORD (TECHNICAL COLLEGE).

Axtell, Minnie, 21, designer—Book-keeping (3d)
Braithwaite, George Frederick, 19, warehouse-man—German (3d)
Chapman, John Valentine, 13, scholar—Book-keeping (3d)
Dewhirst, Alfred, 20, mill hand—French (3d)
Dunn, Willie, 27, clerk—German (3d)
Garnett, George, 20, manager—French (3d)
Greenwood, John Russell, 15, student—Book-keeping (3d)
Hall, Charles Arthur, 15, student—Book-keeping (3d)
Hanson, Thomas William, 15, student—Book-keeping (2d)
Klepper, Frederick Whitehead, 18, tobacconist's assistant—German (1st)
Medcalf, Geoffrey Kirby, 22, solicitor's clerk—French (3d)
Naylor, Edward, 14, student—Book-keeping (3d)
Roberts, Arthur, 16, student—French (3d); Book-keeping (3d)
Schmidt, Arno, 20, student—French (3d)
Smith, Edward, 18, coal merchant—Book-keeping (2d)
Sutcliffe, Herbert Mortimer, 26, warehouse assistant—Spanish (3d)
Hade, Frank Luther, 23, manufacturer—Spanish (3d)
Walker, Ada Jane, 30 (no occupation)—German (3d)
Whitaker, A. D. 15, scholar—Book-keeping (3d)

BRECON (MIDDLE-CLASS SCHOOL).

Evans, Ethelbert, 15, student—English (3d)
Evans, John Williams P., 15, scholar—Commercial Geography (2d)
Powell, Evan Lewis, 22, teacher—Commercial Geography (1st)
Watkins, Archibald Greenwood, 14, student—English (2d)
Williams, Watkin Gwynne Lewis, 15 (no occupation stated)—Commercial Geography (2d)

BURNLEY (MECHANICS' INSTITUTE).

Arnold, William, 18, weaver — Shorthand (3d)
Bardsley, Arthur, 20, clerk—Book-keeping (1st), and the Society's bronze medal
Biggs, William Julian, 19, weaver—Book-keeping (3d)
Briggs, John Willy, 17, cotton weaver—Book-keeping (2d); Shorthand (2d)
Chew, Benjamin, 16, weaver—Book-keeping (3d)
Crabtree, William Robert, 15, book-keeper—Book-keeping (1st)
Hargreaves, George E., 22, weaver—Shorthand (3d)
Hargreaves, James, 14, weaver—Book-keeping (3d)
Hargreaves, William Edward, 17, clerk—Shorthand (2d)
Hartley, Alfred, 16, clerk—Book-keeping (2d)
Heelis, Fred., 24, baker—Shorthand (2d)
Hindle, David, 25, clerk—Shorthand (2d)
Hollinrake, Harold, 17, clerk—English (2d); Book-keeping (2d); Shorthand (3d)
Hollinrake, Wilfrid, 15, clerk — Shorthand (3d)
Houlding, Lawrence, 18, weaver—Shorthand (2d)
Hoyle, Richard Birch, 17, weaver—English (3d)
Jump, Richard, 20, twister—Shorthand (3d)
Lord, Jane Elizabeth, 20, teacher—Shorthand (3d)
Rhodes, Emma, 19, clerk—Shorthand (2d)
Shackleton, Edwin, 18, book-keeper—Shorthand (3d)
Stevens, Eunice, 20, weaver—English (3d)
Thornber, William, 20, grocer's assistant—Book-keeping (2d)
Todd, William, 37, weaver—English (2d)
Walker, John Winterbottom, 18, cotton weaver—English (3d)
Winterbottom, James, 19, twister—Book-keeping (2d)

CARLISLE.

Armstrong, Alfred Edward, 15, scholar—English (2d)

CARRON.

Andrews, William Adam, 20, clerk—Shorthand (3d)
Bacon, John D., 19, clerk—Shorthand (3d)
English, William, 23, clerk—Shorthand (3d)
Maclean, James W., 23, clerk—Shorthand (3d)

CHORLEY.

Bennett, Arthur, 23, salesman—Book-keeping (2d)
Grundy, William, 20, cotton waste dealer—Book-keeping (3d)
Leigh, James, 17, bank clerk—Book-keeping (2d)
Tattersall, Arthur, 25, book-keeper—Book-keeping (2d)

CONSETT.

Davies, Thomas, 32, clerk—Book-keeping (3d)
Gillies, William Thomas, 35, clerk—Book-keeping (2d)
Harrison, Charles Edward, 22, clerk—Book-keeping (2d)
Longworth, Thomas, 21, commercial clerk—Book-keeping (2d)
Swales, George, 30, commercial clerk—Book-keeping (3d)

DALTON-IN-FURNESS.

Backhouse, William Thomas, 18, fitter's apprentice—Shorthand (3d)
Fox, William Arthur, 15, clerk—Shorthand (3d)
Pickthall, Mark, 26, builder's clerk—Shorthand (3d)

DUNDEE.

Allan, James Reid, 22, law clerk—Shorthand (3d)
Cumming, James L., 19, clerk—Shorthand (3d)
Finlayson, William, 18, clerk—Shorthand (3d)
Gordon, Thomas Dick, 18, clerk—Shorthand (3d)
Honeyman, David Livingstone, 18, accountant's clerk—Book-keeping (3d)
Keay, David D., 19, compositor—Shorthand (3d)
Keiller, James, 25, clerk—Shorthand (3d)
Lickley, David, 17, clerk—Book-keeping (2d)
Matthew, Alexander Parker, 17, clerk—Shorthand (3d)
Millar, William James, 20, clerk—Shorthand (3d)
Ogg, Helen, 20, paper folder—Shorthand (3d)
Phillip, Robert Dorward, 15, scholar—Shorthand (3d)
Potter, William Nicoll, 27, clerk—Book-keeping (2d)
Robertson, Frederick, 17, clerk—Shorthand (3d)
Ross, David Begg, 19, law apprentice—Shorthand (3d)
Smith, William K., 33, clerk—Shorthand (2d); Book-keeping (2d)
Soutar, Charles, 19, law apprentice—Shorthand (3d)
Wighton, James Donald, 17, law apprentice—Shorthand (3d)
Wylie, Thomas Pettigrew, 15, scholar—Shorthand (3d)
Young, Allan M., 19, clerk—Shorthand (3d)
Young, George Gilfillan, 13, scholar—Shorthand (3d)

EARLESTOWN.

Alderson, John Henry, 20, clerk — Book-keeping (2d)
Ball, William, 27, clerk—Book-keeping (1st)
Barr, John, 19, clerk—Book-keeping (1st)
Beyer, George Joseph, 25, stationer—Book-keeping (1st)
Cooke, John, 22, clerk—Book-keeping (1st)
Crawford, George, 18, clerk—Book-keeping (2d)
Graham, Alfred Henry, 22, clerk — Book-keeping (1st)
Swift, Thomas, 25, clerk—Book-keeping (1st)

FARNHAM.

Bentall, Reginald Henry, 13, scholar—Book-keeping (3d)
Brown, Percy, 15, student—Book-keeping (3d)
Burningham, Arthur Winkworth, 14, student —Book-keeping (3d); English (3d)
Hart, Gilbert, 14, scholar—Book-keeping (3d)
Hill, Nellie Beatrice, 14, scholar—Book-keeping (3d)
Parkinson, Arthur, 15, scholar—Book-keeping (2d)
Smither, Harry, 13, scholar—Book-keeping (2d)
Williams, Kate Mabel, 15, scholar—Book-keeping (2d)

GLASGOW (ATHENÆUM).

Alexander, Jessie Sharp N. 19 (no occupation stated)—Shorthand (3d)
Barbour, Robert, 18, clerk—Shorthand (3d)
Begg, Alexander Hood, 26, clerk—Commercial Geography (1st), the Society's Bronze Medal, and the City Companies' First Prize of £3
Bisset, William, 22, clerk—Shorthand (3d)
Blair, Agnes Beatson, 21 (no occupation stated)—French (2d)
Boyd, Thomas, 21, mercantile clerk—Shorthand (3d)
Breen, William H., 23, clerk—Book-keeping (3d)
Brewster, Francis O., 18, clerk—Shorthand (3d)
Brown, James C., 22, house factor—Book-keeping (3d)
Brown, William M., 22, clerk—Spanish (1st).
Browne, George Archibald, 22, clerk—French (1st)
Bryden, John Goldie, 24, flour miller—German (1st)
Cairns, John, 27, seed merchant—German (1st)
Carmichael, John, 18, clerk—German (1st)
Chalmers, John Crawford, 19, clerk—Shorthand (3d)
Craig, James, 23, clerk—German (1st)
Craig, James Halliday, 14, scholar—Shorthand (3d)
Cuthbert, Wm., 23, clerk — Book-keeping (1st)
Donald, John, 18, clerk—Shorthand (1st).
Douglas, John, 32, colliery traveller—Shorthand (2d)
Downie, Donald, 26, clerk—Spanish (1st).
Duncan, Andrew, 17, invoice clerk—Book-keeping (3d)
Edwards, James Patrick, 19, clerk—German (1st); French (2d)
Ewing, William, 19, time keeper—Shorthand (3d)
Falconer, John Malcom, 24 (no occupation stated)—Commercial Geography (1st)
Fraser, Archibald, 20, clerk—Shorthand (3d).
Fulton, William, 19, warehouseman—French (1st)
Fulton, William, 21, apprentice lithographer —Shorthand (1st)
Gilchrist, John, 20, clerk—Shorthand (3d)
Gilmour, James Tannahill, 20, clerk—Shorthand (3d)
Gloag, James, 24, mercantile clerk—Shorthand (2d)
Gordon, Herbert Frank, 16, lawyer's clerk—Shorthand (3d); German (3d)
Grant, James Gemmell, 22, railway clerk—Shorthand (3d)
Gordon, John, 32, cashier—Commercial Geography (1st) and the City Companies' Second Prize of £2
Gunn, James B., 19, manufacturer's salesman —Shorthand (3d)
Hamilton, Alexander, 17, clerk — German (1st)
Hamilton, Daniel, 17, clerk—French (2d)
Hamilton, David, 18, clerk—Shorthand (3d)
Hamilton, Eliza, 16, scholar—French (2d)
Hay, Alexander, 22, clerk—Shorthand (3d)
Henderson, John, 25, clerk—French (2d); German (1st)
Hill, James, 31, clerk—German (1st)
Howie, James D., 22, clerk—Shorthand (3d)
Johnston, William Bruce, 40, clerk—Book-keeping (3d)
Ker, Adam, 17, clerk—Book-keeping (2d)
Kerr, James, 15, clerk—Shorthand (1st)
Kynd, Duncan, 21, leather salesman—Shorthand (3d)
Lees, Robert Munro, 26, clerk—French (1st), the Society's Bronze Medal, and the City Companies' 2nd prize of £2
Lennox, James Martin, 20, warehouseman—Shorthand (3d)
Love, John Y., 23, clerk—Book-keeping (2d)
McAndrew, John, 27, shipping clerk—German (1st)
McCartney, Hugh P., 19, clerk—French (2d)
McCulloch, John, 26, clerk—Shorthand (3d)
MacDonald, Alexander, 28, tailor and clothier —English (2d)
Macdonald, Daisy, 17, scholar—French (2d)
Macdonald, John, 17 (no occupation stated) —Shorthand (2d)
McDougall, William, 22, clerk—Book-keeping (2d)
McGill, Robert Wilson, 22, clerk—Theory of Music (3d); Spanish (2d)
McGregor, James, 27, clerk—Book-keeping (3d)
McIntosh, William, 36, clerk—Spanish (3d)
McIntyre, Neil, 23, assistant grocer—Book-keeping (3d)
McKee, Henry 15, (no occupation stated)—Shorthand (3d)
Mackenzie, Donald, 39, teacher—German (1st)

Macpherson, Malcolm D., 25, law clerk—Shorthand (2d)
Matheson, Alexander, 15, scholar—Shorthand (2d)
Meiklejohn, Edward, 18, clerk—Shorthand (3d)
Miller, John, 22, clerk—Book-keeping (2d)
Milligan, Jas., 19, clerk—Book-keeping (1st); Arithmetic (1st)
Montereau, O. L. Marie de, 24, piece-goods assistant—German (1st)
Neill, T. Gardner, 20, stationer—German (2d)
Munro, Andrew, 27, clerk—Spanish (3d)
Neish, David, 21, clerk—Theory of Music (3d)
Nicholson, William John, 21, student—French (2d)
Niven, Richard, 27, clerk—Shorthand (3d)
Plant, Thomas Duncan, 19, accountant's clerk—Shorthand (3d)
Raeburn, Robert Wm., 19, clerk—Shorthand (3d)
Ramsay, Thomas H., 23, clerk—Shorthand (3d)
Rankin, Alexander R., 15, clerk—Shorthand (3d)
Scotland, John H., 17, clerk — Shorthand (3d)
Simpson, Frederick William, 18, (no occupation stated)—Spanish (2d)
Smith, Robert, 19, railway clerk—Shorthand (3d)
Thomson, Arthur, 19, coalmaster's clerk—Shorthand (3d)
Thompson, Kate Walters 24, (no occupation stated)—Shorthand (3d)
Walker, Annie F., 18, book-keeper—Shorthand (3d)
Wallace, James, 22, clerk—Book-keeping (2d)
Wilson, James N., 19, clerk—Shorthand (3d)
Wilson, Thomas Leitch, 18, clerk—English (3d)
Winter, Samuel, 22, commercial clerk—Spanish (2d)
Wylie, Alexander, 32, teacher—Book-keeping (2d); French (2d)
Young, Elizabeth B., 22, teacher—French (2d)
Young, Margaret Paulin, 27, teacher—French (1st)
Yuile, Louisa Janet, 18, correspondent—Shorthand (3d)

GLASGOW (YOUNG MEN'S CHRISTIAN ASSOCIATION, SOUTHERN SECTION).

Creighton, James Swan, 23, draper—Book-keeping (3d)
Dickson, Thomas, 24, clerk—Book-keeping (2d)
Forrester, Thomas Carlaw, 16, clerk—Book-keeping (3d)
Lochhead, James, 29, clerk—Book-keeping (2d)
McCormick, Alexander, 15, clerk—Book-keeping (2d)
Rae, George, 32, clerk—Book-keeping (2d)
Strang, John, 17, bank apprentice—Book-keeping (1st)
Taylor, David, 17, clerk—Book-keeping (2d)
Wight, George Wink, 20, accountant's clerk—Book-keeping (2d)

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

Buchanan, Daniel, 19, watchmaker—Theory of Music (3d)
Brown, William Morrison, 25, photographer and zincotyper—Theory of Music (3d)
Ballantyne, Thomas A., 22, warehouseman—Theory of Music (3d)
Davidson, William Crawford, 26, china decorator—Theory of Music (2d)
Gray, Robert, 24, upholsterer—Theory of Music (3d)
Hall, William Clark, 20, jeweller—Theory of Music (1st)
Houston, David, 21, warehouseman—Theory of Music (3d)
Jarvie, William, 41, blacksmith—Theory of Music (2d)
Lindsay, James, 23, cooper—Theory of Music (3d)
McKendrick, John, 30, clerk — Theory of Music (2d)
Richie, James Jack, 23, dyer—Theory of Music (3d)
Small, James Kay, 20, grocer—Theory of Music (3d)
Tennant, George Finlay, 22, tobacco-pipe maker—Theory of Music (2d)

HARROW-ON-THE-HILL.

Page, Bessie Maria, 18 (no occupation stated)—Book-keeping (3d)
Short, Agnes Anne, 19, clerk—Book-keeping (3d)
Smith, Agnes, 18 (no occupation stated)—Book-keeping (2d)

HOWNAM.

Cuthbert, Hannah, 16, scholar — Domestic Economy (3d)
Cuthbert, James, 48, schoolmaster—Domestic Economy (2d)
Cuthbert, Jessie Anne, 14, scholar—Domestic Economy (3d)

HUDDERSFIELD (TECHNICAL SCHOOL).

Bell, Frank, 16, bookbinder—Book-keeping (3d)
Bradbury, Charles Edward, 25, assistant manager of workshop—French (3d); German (2d)
Dawson, Alexander Hugh, 18, clerk—French (3d); German (2d)
Lister, Walter, 23, weft deliverer—Book-keeping (3d)
Sheard, John Henry, 17, clerk—Book-keeping (3d)
Thorpe, Laura Ellen, 21, elementary school teacher—French (3d)

HUDDERSFIELD (YOUNG MEN'S CHRISTIAN ASSOCIATION).

Leonard, Harry, 24, clerk—French (3d)
Mellor, Albert Gilling, 37, clerk—Book-keeping (1st)
Mellor, Herbert, 21, clerk—Shorthand (3d)
Senior, H., 20, clerk—Book-keeping (1st)

Speight, Harry, 21, blanket-weaver—Book-keeping (3d)
Winfield, Fred, 15, accountant's clerk—Book-keeping (2d)

HULL (CHURCH INSTITUTE).

Brownlow, Richard, 27, merchant's clerk—German (1st)
Evington, Herbert, 26, engineer's draughtsman—German (1st)
Mayman, William Henry, 22, clerk—German (1st)

HULL (YOUNG PEOPLE'S CHRISTIAN AND LITERARY INSTITUTE).

Anderson, James Taylor, 43, clerk—Book-keeping (3d)
Baker, George, 30, book-keeper—Theory of Music (1st)
Barchard, Lillie, 17 (no occupation stated)—Theory of Music (3d)
Bielby, Elizabeth A., 31, teacher of music—Theory of Music (2d)
Bird, Walter, 19, clerk—Shorthand (1st)
Cherry, Fred. Aquila, 18, clerk—Book-keeping (3d)
Cox, Edwin, 19, driller—Theory of Music (3d)
Duncan, Walter Edwin, 19, clerk—Book-keeping (2d)
Goodge, Abraham, 20, corn porter—Theory of Music (3d)
Hollingworth, Susan, 18, typist—Type-writing (3d)
Hudson, Edwin H., 22, collector—Book-keeping (2d)
Jackson, John William, 23, shorthand and type-writing clerk—Shorthand (1st)
Owst, Arthur Maynard, 22, merchant's clerk—Book-keeping (2d); Theory of Music (2d)
Owst, James Francis, 24, clerk—Book-keeping (3d)
Raper, Alfred Avery, 17, clerk—Book-keeping (1st)
Richardson, Edith Mary, 16, scholar—Theory of Music (2d)
Robinson, Henrietta Eleanor, 18 (no occupation stated)—Theory of Music (2d)
Singleton, William, 21, clerk—Book-keeping (2d)
Smith, Walter, 24, clerk—Book-keeping (1st)
Strachan, Ethel L., 16 (no occupation stated)—Theory of Music (3d)
Symonds, Samuel Harry, 19, draper's assistant—Book-keeping (3d)
Thompson, Emma, 37 (no occupation)—Theory of Music (3d)
Thorp, Ethel Maria, 18, teacher—Theory of Music (2d)
Williamson, Edward Lang, 30, law clerk—Book-keeping (3d)

IPSWICH (WORKING MEN'S COLLEGE).

Butcher, Frank, 14, student—Book-keeping (3d)
Catchpole, William, 15, scholar—Book-keeping (3d)
Holmes, Harry Arthur, 20, clerk—Theory of Music (3d)
Raffe, William, 14, student—Book-keeping (3d)

LEEDS (YORKSHIRE COLLEGE).

Josephy, Hermann, 20, woollen merchant—German (1st), with the Society's Bronze Medal, and the City Companies' Second Prize of £2; Spanish (1st), and the Clothworkers' Company's Third Prize of £2; French (2d)

LEEDS (YOUNG MEN'S CHRISTIAN ASSOCIATION).

Baillie, Maria Florence, 25, student—Domestic Economy (2d)
Bell, Evelyn, 22, student—Domestic Economy (1st)
Brayshaw, Clara, 33, student—Domestic Economy (2d)
Brooke, Margaret A., 21, student—Domestic Economy (1st)
Brown, Harry, 24, clerk—Book-keeping (2d)
Crilly, Bertha Maud, 18, student—Domestic Economy (2d)
Crosby, Martha Eliza, 20, student—Domestic Economy (1st)
Culpin, Henry, 31, clerk—Book-keeping (1st)
Dupré, Flora, 33, student—Domestic Economy (2d)
Foster, Fanny B., 20, student—Domestic Economy (3d)
Griesbach, Sophia Ethel, 17, student—Domestic Economy (3d)
Iredale, Sarah Frances Louise, 20, student—Domestic Economy (2d)
Jackson, Minnie Jane, 32, student—Domestic Economy (3d)
Lancaster, Louisa, 23, student—Domestic Economy (2d)
Latchmore, Mary Windsor, 18 (no occupation stated)—Domestic Economy (2d)
Leedham, Janie, 25, student—Domestic Economy (3d)
Newey, Alfred E., 21, clerk—Book-keeping (2d)
Newey, Franois William, 25, clerk—Book-keeping (2d)
Nicholson, Fanny Isabel, 20, student—Domestic Economy (2d)
Olliff, Edith, 21, student—Domestic Economy (1st)
Paterson, Thomas, 21, clerk—Book-keeping (2d)
Riley, Thomas Charles, 21, clerk—Book-keeping (1st)
Roberts, Edith Elliot, 22, student—Domestic Economy (2d)
Share, Constance, 30, student—Domestic Economy (2d)
Shaw, Edith, 21, student—Domestic Economy (1st)
Singleton, John, 35, hammer shaft-maker—Book-keeping (3d)
Smith, Florence Elizabeth, 17, student—Domestic Economy (2d)
Smith, Mary Emily, 22, student—Domestic Economy (2d)
Smith, Walter, 20, clerk—Book-keeping (2d)
Smithson, Emily Isabel, 22, student—Domestic Economy (2d)

Spink, Eleanor, 24, student — Domestic Economy (2d)
Staples, Annie, 26, student — Domestic Economy (2d)
Taylor, Benjamin, 25, clerk—Book-keeping (1st)
Taylor, Fanny Bell, 26, student—Domestic Economy (2d)
Taylor, George, 18, clerk—Book-keeping (2d)
Towers, Sarah Isabel, 20, student—Domestic Economy (2d)
Tyzack, Jane, 26 (no occupation stated)—Domestic Economy (2d)
Westcott, Edith L. 29, student—Domestic Economy (3d)
Wilson, William, 32, clerk—Book-keeping (3d)
Wordsworth, Myra, 30, student—Domestic Economy (3d)

LEICESTER (WORKING MEN'S COLLEGE).

Brant, Charles James, 20, clicker—Theory of Music (2d)
Godwin, George Hetterley, 19, joiner's apprentice—Theory of Music (3d)
Lucas, William Henry, 17, clerk—Shorthand (3d)
Morris, Fred, 23, clicker—Theory of Music (2d)
Platts, Charles, 40, cashier—Book-keeping (3d)
Procter, John, 19, clerk—Shorthand (3d)
Salter, Charles Albert, 18, clerk—Shorthand (3d)
Southwell, Joseph, 22, clicker—Theory of Music (3d)
Springthorpe, Albert, 24, grocer's assistant—Theory of Music (3d)
Townsend, Walter John, 20, clerk—Shorthand (3d)
Tricks, John Lawrence, 20, clerk—Shorthand (3d)
Underwood, Isaac Reuben, 17, juvenile outfitter—Theory of Music (2d)
Webber, Frederick Charles James, 24, grocer's assistant—Book-keeping (1st); Theory of Music (3d)

LEWISHAM (ELSWICK INSTITUTE).

Brown, John, 30, teacher—Book-keeping (3d)
Burch, Arthur James, 24, clerk—Book-keeping (2d)
Forward, Alfred Elias, 20, clerk—Book-keeping (1st)
Franks, Augusta, 23 (no occupation stated)—Book-keeping (3d)
Franks, Julie, 21 (no occupation stated)—Book keeping (2d)
Nelson, Catherine, 20 (no occupation stated)—Book-keeping (2d)
Reynolds, Catherine Louisa, 17 (no occupation stated)—Book-keeping (2d)
Rowland, Harry, 29, schoolmaster—French (2d)
Wagstaffe, George Reginald, 30, schoolmaster—Book-keeping (3d)
Wallis, James Edward, 23, teacher—French (3d)
Walter, Harry George, 15, teacher—Book-keeping (3d)
Whittaker, Nathan, 29, schoolmaster—Book-keeping (3d)

LIVERPOOL (BALFOUR INSTITUTE).

Brimley, Frank John, 16, apprentice—Book-keeping (2d)
Burrowes, Frederick John, 21, clerk—Book-keeping (2d)
Carter, Thomas Hall, 19, clerk—Book-keeping (1st)
Crew, Henry, 22, clerk—Book-keeping (3d)
Finlason, Eric C., 22, clerk—Book-keeping (3d)
Jones, John Charles, 22, clerk—Book-keeping (1st)
Lang, Henry Esplen, 22, clerk—Book-keeping (1st)
Martin, Harry, 15, clerk—Shorthand (3d)
Quinsey, Adam, 23, clerk—Book-keeping (1st)
Roberts, Edward, 37, clerk—Book-keeping (1st)
Roberts, Frederick Charles, 19, clerk—Book-keeping (2d)
Shaw, James Richard, 27, cashier—Book-keeping (1st)
Stansbie, William H. H., 25, clerk—Book-keeping (1st)

LIVERPOOL INSTITUTE.

Adams, Peter George, 16, scholar—Book-keeping (2d)
Archer, Charles, 20, cotton salesman—Book-keeping (1st)
Astbury, Arthur, 14, scholar—Book-keeping (2d)
Barkla, Charles Glover, 14, scholar—Book-keeping (1st)
Barlow, Charles, 15, scholar—Book-keeping (2d)
Barron, James, 23, secretary—Book-keeping (2d)
Bennett, John Charles, 15, clerk — Book-keeping (2d)
Bradburn, Frederick James, 16 (no occupation stated)—Book-keeping (2d)
Brown, Charles, 33, clerk—Book-keeping (1st)
Burn, Eric, 14, student—Book-keeping (2d)
Carmichael, John Fisher, 15, scholar—Book-keeping (2d)
Cartmel, Edwin Charles, 15, scholar—Book-keeping (2d)
Chamberlain, Ernest T., 15, scholar—Book-keeping (2d)
Clarke, McDonald Pollock, 14, scholar—Book-keeping (3d)
Cobb, Robert Bennett, 15, scholar—Book-keeping (1st)
Collinge, Robert Abraham, 22, grocer's assistant—Book-keeping (2d)
Couldrey, Paul Sidney, 16, scholar—Book-keeping (2d)
Culligan, Stephen, 29, clerk—Book-keeping (2d)
Davies, Thomas Ellis, 14, scholar—Book-keeping (2d)

Dixon, Walter Christopher, 15, scholar—Book-keeping (2d)
Douglas, John, 15, scholar—Book-keeping (2d)
Edwards, George Henry, 28, clerk—Book-keeping (1st)
Ellis, Harry Newton, 16, clerk—Book-keeping (1st)
English, James Everest, 14, scholar—Book-keeping (2d)
Ewart, Robert James, 15 (no occupation stated)—Book-keeping (2d)
Finch, Arthur Leighton, 15, scholar—Book-keeping (2d)
Fisher, Paul, 15, scholar—Book-keeping (1st)
Fogg, Frederic George, 16, scholar—Book-keeping (2d)
Furniss, Laura, 16 (no occupation stated)—Book-keeping (3d)
Grant, Alexander, 21, clerk—Book-keeping (1st)
Ham, William Israel, 14, scholar—Book-keeping (2d)
Hancock, Henry Tom, 14, scholar—Book-keeping (1st)
Harding, Akland Roberts, 15, scholar—Book-keeping (2d)
Harris, John E., 19, clerk—Book-keeping (2d)
Hughes, Alfred, 14, scholar—Book-keeping (2d)
Hunt, Frank Fletcher, 15, scholar—Book-keeping (2d)
Hunt, Henry, 15, office boy—Book-keeping (2d)
Hyde, Frank King, 14, scholar—Book-keeping (1st)
Jackson, Sydney Charles, 24, clerk—Book-keeping (2d)
Johnson, Henry Gibson, 15, scholar—Book-keeping (1st)
Jones, Edward Redmayne, 14, scholar—Book-keeping (2d)
Jones, Griffith, 15, scholar—Book-keeping (2d)
Kearne, Edith Vernon, 26, lady-help—Book-keeping (3d)
Kissock, Robert S., 15, scholar—Book-keeping (3d)
Langley, Bertram, 16, scholar—Book-keeping (1st)
Lee, Oliver Gatenby, 19, clerk—Book-keeping (2d)
Lloyd, John Barrow, 14, scholar—Book-keeping (2d)
Long, John Lawrence, 15, messenger—Book-keeping (2d)
Lowry, Sidney S., 23, shop assistant—Book-keeping (2d)
Lucas, Henry, 19, clerk—Book-keeping (2d)
Lunberg, Frederick Alfred, 18, clerk—Book-keeping (2d)
McKnight, Frank, 15, scholar—Book-keeping (2d)
McTaggart, Alexander, 15, scholar—Book-keeping (3d)
Makin, William, 14, scholar—Book-keeping (2d)
Middleton, David, 15, scholar—Book-keeping (2d)
Milburn, Thomas W., 15, office boy—Book-keeping (3d)
Morgan, Katherine, 17 (no occupation)—Book-keeping (3d)
Morgan, Louisa, 22 (no occupation)—Book-keeping (1st)
Morton, Charles Crichton, 15, scholar—Book-keeping (2d)
O'Reilly, Thomas John, 18, clerk—Book-keeping (2d)
Owen, John David, 14, scholar—Book-keeping (2d)
Peach, Arthur, 15, clerk—Book-keeping (2d)
Pearson, Henry James, 15, scholar—Book-keeping (2d)
Pennington, Harold V., 14, scholar—Book-keeping (2d)
Penston, Andrew Joseph, 15, scholar—Book-keeping (2d)
Pye, Henry Edwin, 24, clerk—Book-keeping (3d)
Roberts, William, 15, scholar—Book-keeping (2d)
Rose, Percy Jesse, 13, scholar—Book-keeping (2d)
Scott, Andrew, 15, scholar—Book-keeping (2d)
Shankland, James, 13, scholar—Book-keeping (2d)
Sinton, William, 15, scholar—Book-keeping (2d)
Smith, Hamilton, 16, office-boy—Book-keeping (1st)
Stanley, Henry Herbert, 16, clerk—Book-keeping (3d)
Stewart, Charles Henry, 15, scholar—Book-keeping (2d)
Swift, George Ernest, 16, scholar—Book-keeping (2d)
Swift, John Harper, 18, clerk—Book-keeping (1st)
Symons, Isabel Miller, 20, shop assistant—Book-keeping (1st)
Tebbutt, Ernest, 13, scholar—Book-keeping (1st)
Thompson, Frederick, 14, scholar—Book-keeping (2d)
Thomson, William, 16, scholar—Book-keeping (2d)
Tongue, Harry, 16, clerk—Book-keeping (1st)
Ulyett, George, 17, clerk—Book-keeping (2d)
Ulyett, Percy, 15, scholar—Book-keeping (2d)
Walker, Stanley, 17, clerk—Book-keeping (2d)
Warburton, Ernest, 14, scholar—Book-keeping (3d)
Williams, Owen Thomas, 15, scholar—Book-keeping (2d)
Williams, William K., 16, scholar—Book-keeping (3d)
Wilson, Edward, 22, clerk—Book-keeping (1st)
Wiswall, Walter Hartley, 15, scholar—Book-keeping (2d)
Wood, Bryan Jardine, 15, scholar—Book-keeping (1st)
Wood, James Frederick Jardine, 19, apprentice—Book-keeping (1st)
Worgan, Alfred Edward, 15, scholar—Book-keeping (2d)

LIVERPOOL (YOUNG MEN'S CHRISTIAN ASSOCIATION).

Askew, Frank S., 20, clerk—English (2d)
Atkins, Francis James, 31, forwarding clerk—Book-keeping (1st)
Bach, John Benjamin, 22, cashier—Book-keeping (2d)
Baxter, Bernard W., 19, clerk—Book-keeping (1st)
Beckett, William Edmund, 24, clerk—Arithmetic (2d); Book-keeping (1st)
Benson, William Henry, 18, timekeeper—Book-keeping (1st)
Beszant, Frederick Henry, 20, clerk—Book-keeping (3d)
Bird, John Simpson, 23, assistant book-keeper—Book-keeping (2d)
Birtles, Arthur John, 21, clerk—Book-keeping (2d)
Bradley, Charles, 24, clerk—Book-keeping (2d)
Bretherton, Henry Volney, 24, correspondent—Book-keeping (1st)
Brock, Arthur William, 20, clerk—Book-keeping (1st)
Burke, Thomas, 26, book-keeper—Book-keeping (2d)
Byrne, William John, 12, scholar—Book-keeping (3d)
Caldwell, Francis, 32, accountant—Shorthand (3rd)
Call, Samuel John, 18, clerk—Book-keeping (1st)
Capsticks, Thomas, 15, scholar—Book-keeping (2d)
Carter, Alfred Charles, 17, accountant—Book-keeping (3d)
Clough, Walter John, 26, correspondent—Book-keeping (3d)
Colebourn, George, 33, telegraphist—Book-keeping (1st)
Crean, John Fitzgerald, 15, scholar—Book-keeping (2d)
Crebbin, Charles, 24, clerk—Book-keeping (2d)
Crofts, John Pape, 22, shipping clerk—Book-keeping (1st)
Culshaw, George, 13, scholar—Book-keeping (2d)
Currie, William C., 24, clerk—Book-keeping (2d)
Davies, William Sennett, 21, clerk—Book-keeping (3d)
Dodd, Thomas Winder, 31, clerk—Book-keeping (2d)
Dunlop, John, 18, clerk—Book-keeping (2d)
Dunning, Henry Edward, 13, scholar—Book-keeping (2d)
English, Wellington Samuel Joseph, 27, stationer—Book-keeping (1st)
Faraday, John Thompson, 22, clerk—Book-keeping (2d)
Ferns, Francis, 13, scholar—Book-keeping (2d)
Fothergill, Mark, 20, clerk—Shorthand (3d); Book-keeping (2d)
Fowler, Henry Alexander, 17, clerk—Shorthand (2d)
Foxcroft, John Hartley, 22, typist—Shorthand (3d)
Fraser, Donald Hugh, 20, clerk—Book-keeping (1st)
Gaunt, Charles Edward, 23, clerk—Book-keeping (2d)
Green, Frederick, 20, clerk—Book keeping (2d)
Griffiths, James, 24, receiver—Book-keeping (2d)
Haspray, George Joseph, 21, gardener—Shorthand (3d)
Holden, William, 21, clerk—Book-keeping (1st)
Hughes, Hugh Edward, 22, clerk—Spanish (2d)
Irving, John A., 23, clerk—Book-keeping (1st)
Ley, William Vawdrey, 20, typist—Book-keeping (2d)
Lovelady, Henry, 13, scholar—Book-keeping (2d)
McLaughlin, Basil, 12, scholar—Book-keeping (2d)
Malvern, Harry Arthur, 29, clerk—Book-keeping (2d)
Monteath, William Alexander, 22, clerk—Book-keeping (2d)
Outram, Arthur, 22 (no occupation stated)—Book-keeping (3d)
Radcliffe, Charles Ernest, 18, clerk—Book-keeping (1st)
Radcliffe, Harold, 24, clerk—Book-keeping (3d)
Ranken, Bryce William, 22, clerk—Book-keeping (2d)
Roberts, Charles Arthur, 18, clerk—Book-keeping (2d)
Roberts, George John, 29, book-keeper—Book-keeping (3d)
Roberts, John Wm., 23, clerk—Book-keeping (1st)
Roberts, Owen Morley, 22, clerk—Book-keeping (2d)
Roberts, Robert Henry, 18, clerk—Book-keeping (1st)
Russell, Ronald William, 20, clerk—Book-keeping (1st)
Sanderson, Thomas Chester, 20, clerk—Book-keeping (1st)
Shaw-Rooney, Fred. E. 22, clerk—Book-keeping (1st)
Shrouder, John Bankes, 24, clerk—English (2d)
Smith, Ernest William, 25, clerk—Book-keeping (2d)
Smith, Robert Joseph, 29, clerk—Book-keeping (2d)
Taylor, John, 22, clerk—Book-keeping (1st)
Thomas, William Jeffrey, 22, clerk—Book-keeping (2d)
Timpany, James Crichton, 18, clerk—Book-keeping (2d)
Tither, Walter, 20, clerk—Shorthand (2d)
Troughton, Clement, 21, clerk—Book-keeping (1st)
Walker, Frederick C., 14, scholar—Book-keeping (2d)
Waring, Herbert, 14, scholar—Book-keeping (3d)

Waterhouse, Elizabeth Caroline Robertina, 35, teacher of cookery—Domestic Economy (3d)
Whitehead, William Saul, 15, scholar—Book-keeping (2d)
Willcox, George, 35, clerk—Book-keeping (2d)
Williams, Albert Edward, 19, ship store dealer's assistant—Book-keeping (2d)
Williams, William Robert, 22, clerk—Book-keeping (1st)
Wills, Thos. A. D., 18, clerk—French (2d)
Wilson, Wilfred Ernest, 25, cotton salesman—Book-keeping (2d)
Windle, Albert John, 19, pupil-teacher—Shorthand (2d)
Winterburn, Thomas, 19, apprentice—Book-keeping (3d)

LLANELLY.

Korth, Oswald Adolphus, 36, private tutor—Italian (1st), and the Clothworkers' Company's Third prize of £2

LONDON (ALDENHAM INSTITUTE).

Anderson, John, 22, student—English (2d)
Ballard, George Francis, 18, clerk—Book-keeping (2d)
Barthels, Gustave, 21, clerk—Book-keeping (1st)
Beckett, George, 25, clerk—Spanish (3d)
Borrowman, George Edward, 19, clerk—Shorthand (3d)
Calcott, Alfred Henry, 22, clerk—French (3d); Book-keeping (2d)
Davey, Alfred Henry, 19, clerk—Shorthand (3d)
Haigh, A. W. J., 15, clerk—Shorthand (3d)
Harris, Frederick W., 20 (no occupation)—Book-keeping (2d)
Henderson, James, 25, clerk—French (3d); German (3d)
Holmes, Harry, 19, clerk—Book-keeping (2d)
Keep, John Thomas, 21, clerk—French (3d)
Meacock, James, 20, clerk—Book-keeping (2d)
Milner, Thomas John, 25, clerk—Spanish (2d)
Munro, David, 32, clerk—Book-keeping (2d)
Phillips, Joseph, 22, clerk—Book-keeping (3d)
Rapley, James William, 22, librarian—Book-keeping (2d)
Read, Walter John, 24, clerk—Book-keeping (3d); Shorthand (3d); French (3d); German (3d)
Tackley, Arthur Edward, 21, clerk—Theory of Music (3d)
Watts, William Cantill, 18, assistant—Book-keeping (3d)
Wilkes, Benjamin, 22, clerk—Spanish (3d)

LONDON (BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION).

Allen, Elizabeth, 25 (no occupation stated)—Theory of Music (2d)
Andrews, Ernest James, 21, clerk—Book-keeping (2d)
Attwood, Alfred William, 26, clerk—German (2d)
Atwell, Ernest James, 22, clerk—Book-keeping (3d)
Austin, Charles William, 41, clerk—Book-keeping (3d)
Bailey, Arthur Henry, 20, clerk—Book-keeping (2d)
Bailey, George Stafford, 19, clerk—Book-keeping (3d)
Baker, Minnie, 22, assistant—English (2d)
Barker, James William, 21, clerk—Book-keeping (3d)
Beach-Hicks, Richard Montague Martin, 31, tutor—French (2d)
Beanland, William Arthur, 27, schoolmaster—Commercial Geography (3d)
Birkett, Robert Charles, 19, clerk—Shorthand (3d)
Black, John Stodart, 17, clerk—Arithmetic (2d)
Bowman, David, 23, clerk—Spanish (1st), the Society's Bronze Medal, and the Clothworkers' Company's First Prize of £5
Brimacombe, Fanny Shearme, 34, clerk—French (2d)
Brookes, Alfred William, 30, clerk—Book-keeping (2d)
Brown, William Arthur, 22, clerk—Book-keeping (2d)
Bull, Henry Wm., 21, librarian—German (3d)
Burgoyne, Mabel L., 19, clerk—Book-keeping (3d)
Butler, Ebenezer, 38, teacher—Book-keeping (2d)
Cabeldu, Amy Eliza, 25, teacher—Book-keeping (2d)
Carr, Ernest Adolphus, 24, clerk—English (1st)
Chapman, John William, 19, clerk—Book-keeping (3d)
Clark, Wilhelmina, 32, teacher—German (3d)
Comport, Samuel Charles, 19, clerk—Book-keeping (3d)
Cook, Thomas W., 25, clerk—Book-keeping (2d)
Cooper, Charles Harry, 22, clerk—Book-keeping (2d)
Cooper, Harry Albert, B.A., 30, civil service—German (2d)
Copping, Mabel Rosa, 23, clerk—Shorthand (3d)
Davies, Jane Mogford, 40, clerk—Book-keeping (3d)
Dobson, Herbert Johnstone, 18, clerk—Spanish (3d)
Dorcey, Daniel, 18, clerk—Book-keeping (3d)
Dunlop, John Charles, 21, in building trade—Theory of Music (3d)
Duplex, Edith, 28 (no occupation stated)—English (2d)
Ellingford, Emily Jane, 29, teacher—Book-keeping (3d)
Ferrier, John Kyle, 19, clerk—Book-keeping (3d)
Ferrier, Rudolph Waldemar, 19, clerk—Book-keeping (3d)
Gannaway, Arthur Ernest, 19, clerk—Book-keeping (2d)
Griggs, Herbert William, 25, clerk—Book-keeping (3d)
Haill, William Gilbert, 28, shorthand writer—Portuguese (2d)

Hancock, John Pearce, 21, civil servant—Arithmetic (1st)
Harris, Herbert Walker, 25, clerk—Arithmetic (1st)
Harrison, Edward Arthur, 22, assistant—Shorthand (2d)
Haskins, George Frederick, 18, clerk—Book-keeping (2d)
Hodges, Harry Herbert, 26, clerk—Book-keeping (3d)
Holmes, Harry McDowell, 22, clerk—Book-keeping (2d)
James, Scotney George, 19, student—German (1st)
Jones, Ada Louisa, 30, teacher—French (2d)
Kestner, Mark, 17, clerk—Book-keeping (3d)
Kiddle, David, 30, clerk—Shorthand (3d)
Lenderyou, William Richard, 22, clerk—Book-keeping (3d)
Lewzey, William, 21, shorthand clerk—Shorthand (3d)
Lockey, James, 57, tutor—French (1st), the Society's Bronze Medal, and the City Companies' First Prize of £3; Arithmetic (1st)
Louis, Henry François Julien Valentine, 22 (no occupation)—French (2d)
Macdonald, James Brunton, 25, clerk—Book-keeping (3d)
Manco, Clara Alice, 24, shoe bow maker—Book-keeping (3d)
Maskell, Jane, 28, governess—Theory of Music (3d)
Mitchell, Frederick, 21, telegraphist—Book-keeping (3d)
Moore, Henry Squire, 30, warehouseman—Shorthand (3d)
Morris, Willis Henry, 27, draper—Book-keeping (2d)
Newbery, E. H. Julia, 19 (no occupation stated)—French (3d)
Nurcombe, John Robert, 22, clerk—Book-keeping (2d)
Peacock, Robert Bradley, 21, clerk—Book-keeping (1st)
Percy, Henry Edwin, 27, clerk—Book-keeping (3d)
Reeves, Charles Clifford, 18, commercial clerk—Book-keeping (2d)
Rhodes, Frederick William, 19, clerk—Arithmetic (2d)
Robins, Agnes, 42, governess—Theory of Music (3d)
Rowe, Annie Jane, 26, clerk—Book-keeping (2d)
Sadler, Edward Harry, 19, solicitor's clerk—Shorthand (3d)
Seward, Joseph Shaw, 25, student—Theory of Music (2d)
Sparrow, Adolphus Brooker, 24, clerk—Book-keeping (3d)
Squire, Caroline, 28, clerk—Shorthand (2d)
Swann, Agatha, 32, teacher—French (3d)
Syer, Edwin John, 21, stockbroker's clerk—French (3d)
Thick, Laura, 34 (no occupation stated)—French (1st)
Thompson, Edwin Arthur, 24, civil service clerk—Book-keeping (3d)
Upton, William Frederick, 21, clerk—Book-keeping (2d)
Veigelé, Adrienne, 25, governess—Theory o Music (3d)
Walsh, James Harry, 22, clerk—Book-keeping (3d)
Wilson, William, 22, schoolmaster—Book-keeping (2d); French (2d)
Wilson, William Martin, 34, clerk—Shorthand (2d)
Wood, Frederick Matthew Howe, 26, shorthand correspondent—Shorthand (3d)
Woodger, George John Horace, 18, clerk—Book-keeping (1st)
Woods, Frank John, 29, secretary—Shorthand (2d)

CITY OF LONDON COLLEGE.

Alcorn, David, 25, clerk—Spanish (2d)
Alcorn, Mark Macrae, 31, clerk—German (1st)
Andrews, Charles James, 32, clerk and salesman—Book-keeping (2d)
Baim, John, 22, clerk—Book-keeping (2d)
Banks, Alfred Claude, 21, clerk in Board of Trade—Book-keeping (2d)
Banks, Frederick Stuart Angus, 18, auctioneers' clerk—Book-keeping (1st)
Banks, William Percy A., 20, accountant's clerk—Book-keeping (1st)
Barber, Philip, 19, bank clerk—Spanish (2d)
Barnett, Harriet, 22, teacher — Domestic Economy (2d)
Beard, William Swain, 32, schoolmaster—Book-keeping (2d)
Bonner, Alfred, 48, wine-merchant's foreman—Book-keeping (3d)
Bowers, Herbert, 24, mercantile clerk—Book-keeping (2d)
Bowles, Benjamin, 20, accountant's clerk—Book-keeping (2d)
Denis Boyle, 32, civil service clerk—Arithmetic (3d)
Bruggenkate, Frederick Hermanus John Ten, 17, clerk—Shorthand (3d)
Bryett, Alfred, 16, clerk—Book-keeping (3d)
Capes, Edith Augusta, 21 (no occupation stated)—Theory of Music (3d)
Chambers, Walter, 33, teacher—Book-keeping (2d)
Chick, Walter Ernest, 22, clerk—Book-keeping (1st)
Clark, Samuel Thomas, 20, clerk—Book-keeping (2d)
Clark, William Horace, 28, civil service clerk—Book-keeping (1st)
Croucher, Samuel Henry, 26, accountant's clerk—Book-keeping (2d)
Cubley, Charles, 22, clerk — Book-keeping (2d)
Dalgleish, Thomas Alfred, 16, clerk—Book-keeping (3d)
Davies, George A. G. 23, clerk—Book-keeping (3d)
Davis, Ellen Sarah, 38, teacher—French (3d)
Drabble, Thomas Meeres, 18, clerk—Book-keeping (1st)
Edwards, William Charles, 26, teacher—French (3d)
Egglesfield, Eliza Jane, 17 (no occupation stated)—Theory of Music (3d)

Eilbeck, Margaret, 26, teacher—Book-keeping (2d)
Ellis, Walter, 17, clerk—Book-keeping (2d)
Field, Mary Jane, 15, dressmaker—Theory of Music (3d)
Gardiner, George Hunt, 27, cashier—Book-keeping (1st)
Gaskell, Alfred, 25, clerk—Book-keeping (2d)
Gill, Francis Alfred, 24, in civil service—Italian (2d); French (2d)
Gillies, John, 25, clerk—Book-keeping (2d)
Goodyear, George, 20, printer—Book-keeping (3d)
Goult, William, 33 (no occupation)—Book-keeping (3d)
Graves, William Thomas, 21, clerk—Book-keeping (2d)
Humphreys, David, 30, schoolmaster—French (2d); Book-keeping (2d)
Jarvis, Louis Ibberson, 21, clerk—Spanish (2d)
Jenkins, Charles H. O., 22, clerk—Book-keeping (3d)
Jones, Frank, 49, clerk—Book-keeping (2d)
Jones, Robert David, 24, clerk—Book-keeping (2d)
Kerr, James, 19, clerk—Shorthand (3d)
Kingdon, Eleanor, 22, typist—Shorthand (3d)
McNair, Annette, 20 (no occupation stated)—Theory of Music (3d)
Manning, Ellen, 34, teacher—Book-keeping (1st)
Marsland, Ernest James Hutton, 18, clerk—Shorthand (3d)
Matthews, Thomas, 23, clerk—Book-keeping (2d)
Mayhew, Charles Frederick Bertram, 18, clerk—Book-keeping (2d)
Menzies, Christopher, 18, clerk—Book-keeping (1st)
Miles, Harvey James, 32, clerk—Arithmetic (3d)
Montgomery, Hugh, 24, clerk—Shorthand (3d)
Morgan, Ernest Richard, 33, clerk—French (1st); German (1st), with the Society's Bronze Medal, and the City Company's First Prize of £3
Morriss, Stephen, 21, clerk—Book-keeping (3d)
Palmer, Emily Sarah, 18 (no occupation stated)—Theory of Music (3d)
Parsons, Gerald Owen, 25, clerk—Book-keeping (1st)
Pate, Henry W., 20, clerk—Book-keeping (3d)
Perkins, William H., 18, clerk—Shorthand (3d)
Phillips, Francis, 20, clerk—German (3d)
Pike, Jemima Maria, 18 (no occupation stated)—Theory of Music (3d)
Plank, Morton, 30, teacher—German (1st)
Pringle, Sydney W., 30, clerk—Book-keeping (3d)
Reynolds, Alfred, 25, clerk—Book-keeping (3d)
Rocke, Walter Parker, 22, clerk—Book-keeping (2d)
Runciman, Elizabeth J., 19, typist—Shorthand (3d)
Sainsbury, William Charles, 17, clerk—Book-keeping (3d)
Sassé, Alfred William, 21, clerk—Book-keeping (2d)
Serrano, Robert, 14 (no occupation stated)—Shorthand (3d)
Shackell, Frank, 22, clerk—Book-keeping (2d)
Shackell, William Frederick, 28, clerk—Book-keeping (2d)
Shrimpton, Alfred, 31, clerk—Book-keeping (2d)
Smith, Reginald Wretts, 26, teacher—Book-keeping (3d)
Solomon, Arthur Lewis, 22, clerk—Arithmetic (1st), and the Society's Bronze Medal
Spearing, Arthur Horace, 20, clerk—Book-keeping (2d)
Springett, F. C. J., 26, school master—Book-keeping (3d)
Stephens, Stephen, 39, assistant-master—Book-keeping (2d)
Stumbles, Amy, 27 (no occupation stated)—Shorthand (3d)
Sweet, Sidney George, 28, clerk—Shorthand (2d)
Taplin, William Thomas, 27, clerk—Book-keeping (2d)
Vickers, John Edward, 25, clerk—Book-keeping (2d)
Williams, William John, 18, clerk—Book-keeping (3d)
Wort, Henry George, 33, teacher—French (2d)

LONDON (COLLEGE FOR WORKING-WOMEN).

Aggas, Jessie, 28, clerk—Book-keeping (2d)
Barter, Laura, 22, upholstress—Book-keeping (2d)
Cain, Elizabeth M., 24, clerk—Arithmetic (2d)
Clarke, Mary, 24, clerk—Book-keeping (2d)
Goff, Isabel, 31, book-keeper—Book-keeping (2d)
Jolly, Ellen, 28, clerk—Book-keeping (2d)

LONDON (HILLMARTIN COLLEGE).

Blake, Frederick Ernest, 13, scholar—English (2d)
Chadwick, Frances Mary, 31, teacher—Book-keeping (3d)
Clements, Mary Frances, 25, teacher—Book-keeping (3d)
Harris, Frederick Henry, 13, scholar—English (2d); Book-keeping (3d)
Jacobi, Henri Louis, 14, scholar—English (2d); Book-keeping (3d)
Kelly, Henry Matthew, 15, scholar—English (3d)
Mulvany, Stanley, 12, scholar—English (2d); Book-keeping (2d)
Plowman, Cecil Frederick, 14, scholar—English (2d)
Reed, Mary J., 48, teacher—Book-keeping (2d)
Simmons, George Herbert, 13, scholar—English (1st); Book-keeping (3d)
Stamp, William Josiah, 14, scholar—Book-keeping (2d); English (2d)

Thomson, Ernest John, 16, scholar—English (2d); Book-keeping (3d)
Unwin, Frederick, 14, scholar—Book-keeping (2d)
Vernon, Arthur Francis, 15, scholar—English (3d)
Whish, Charles Albert Edward, 12, scholar—Book-keeping (2d)

LONDON (HOLLOWAY COLLEGE).

Cox, Florence A., 15, scholar—Book-keeping (3d)
Davies, Edith Rose, 15, scholar—Domestic Economy (3d)
Davies, Herbert Paget, 19, chemist's assistant—French (3d)
Deslandes, Percy Edward, 14, scholar—Book-keeping (3d)
Goozee, Florence Maude, 14, scholar—Book-keeping (3d)
Jacobson, Eva R., 15, scholar—English (3d); Domestic Economy (3d)
James, John Francis William, 12, scholar—Arithmetic (3d); Book-keeping (2d)
Marcham, William, 15 (no occupation stated)—Book-keeping (3d); English (3d)
Opperman, William Whytell, 14, scholar—Book-keeping (3d)
Pratt, Mabel L., 13, scholar—Domestic Economy (3d); English (3d)
Snelling, Cecil Benjamin, 14, scholar—Book-keeping (3d)
Spencer, Julia Diana, 16, scholar—Book-keeping (2d)
Stunt, Frank Brulant, 14, scholar—Book-keeping (3d); English (3d)
Sweeting, Alice Maud, 15, scholar—Book-keeping (3d)
Tinson, Harold Reid, 13, scholar—Book-keeping (3d)

LONDON (METROPOLITAN SCHOOL OF SHORTHAND).

Adams, Joseph Wm. Atkin, 19, shorthand clerk—Shorthand (2d)
Adnams, Amy Gertrude, 15, shorthand writer and typist—Typewriting (2d); Shorthand (2d)
Airey, George, 18, pupil—Book-keeping (2d); Shorthand (3d)
Allen, Henry William, 21, clerk—Book-keeping (2d)
Anderson, Arthur Edward, 21 (no occupation stated)—Book-keeping (2d)
Andrews, Alice Emily, 16, shorthand writer and typist—Shorthand (3d)
Atkinson, William, 21, shorthand clerk—Shorthand (3d)
Axworthy, George H., 19 (no occupation stated)—Shorthand (2d)
Bacon, Marie Frederica, 19, shorthand writer and typist—Shorthand (2d)
Banting, Edgar, 30 (no occupation)—Shorthand (3d)
Barker, Walter, 19, attendant British Museum—Shorthand (2d)
Barrett, W. C. M. 24, clerk—Shorthand (3d)
Barrington, Albert Charles Augustus, 20 (no occupation stated)—Shorthand (2d)
Batten, Frederick Lavell, 27, clerk—Shorthand (3d)
Baster, Arthur A., 19, shorthand clerk—Shorthand (2d); Book-keeping (1st)
Beadle, Hugh, 23, clerk—Shorthand (1st)
Bedser, Nelly, 17, shorthand writer and typist—Type-writing (2d)
Bennett, Louise, 19, clerk—Book-keeping (3d)
Bettel, Laura, 18, stenographer—Type-writing (3d)
Biddell, Edward, 34 (no occupation stated)—Book-keeping (2d)
Bock, Bertha, 31, clerk—Shorthand (3d)
Boden, Abel, 21, bill clerk—Shorthand (3d)
Bonwick, Gerald William, 19, salesman—Book-keeping (2d)
Borthwick, Katherine Alleyne, 26 (no occupation stated)—Shorthand (3d)
Bottoms, George, 20, printer—Shorthand (3d)
Boulden, Edith, 24, clerk—Type-writing (1st)
Bowen, Edwin Stanley, 17, clerk—Shorthand (3d)
Bowen, Rosa Edith, 16, shorthand writer and type-writer—Type-writing (2d)
Bowman, Edwin Andrew, 18, clerk—Shorthand (3d)
Bridgland, Henry, 22, clerk—Shorthand (3d)
Brown, Charles, 34, clerk—Shorthand (2d)
Browne, James, 27, schoolmaster—Shorthand (3d)
Browne, William, 26, type-writer—Shorthand (2d)
Buchanan, Anna L., 28 (no occupation)—Type-writing (3d)
Bulford, Marie, 20, foreign corespondent and type-writer—Type-writing (1st)
Burton, Claude Edward Cole Hamilton, 22, journalist—Shorthand (3d)
Byham, Margaret E., 26 (no occupation stated)—Type-writing (3d)
Carlile, Clara, 18, clerk—Shorthand (2d)
Clark, Charles Samuel, 22, clerk—Book-keeping (2d)
Copping, John Alfred, 18, clerk—Shorthand (1st)
Crockett, Charles George, 24, commercial clerk—Book-keeping (1st)
Cross, Florence M., 26 (no occupation stated)—Book-keeping (2d)
Cruickshank, Joyce, 22 (no occupation stated)—Shorthand (3d)
Culver, Albert, 15, clerk—Shorthand (3d)
Curd, Oswald James, 26, clerk—Shorthand (3d)
D'Almeida, Courtenay C., 17 (no occupation stated)—Shorthand (3d)
Davis, William George, 29, schoolmaster—Book-keeping (1st)
De Ville, Francis, 16, clerk—Book keeping (2d)
Dove, Stanley Charles, 20, commercial clerk—Shorthand (3d)
Duffell, Augustus Samuel, 19, clerk—Shorthand (2d)
Elkin, Frederick, 17, clerk—Shorthand (3d)
Elliott, Fanny, 19 (no occupation stated)—Shorthand (3d)
Elliott, Henry Thomas, 20, printer—Shorthand (3d)
Evans, Frederic George, 17, clerk—Shorthand (3d)

Farquharson, P. W. N., 19, student—Book-keeping (2d)
Fenwick, John Frederick, 17 (no occupation stated)—Shorthand (3d)
Fisher, Reginald Fleming, 25, journalist—Shorthand (3d)
Fisk, Arthur William, 21, clerk—Shorthand (3d)
Flint, Alfred J., 18, clerk—Shorthand (3d)
Fox, Arthur Edward, 18, clerk—Shorthand (3d)
Fraher, Steward Sidney, 18, clerk—Shorthand (3d)
Freestone, Horace Suckling, 21, clerk—Shorthand (2d)
Fry, Henrietta Emmeline, 20, shorthand and type-writing clerk—Type-writing (1st)
Gardner, Philip H., 20, shorthand clerk—Shorthand (1st), and the Society's Bronze Medal
Gittins, Walter Delamere, 23, compositor—Shorthand (3d)
Goff, Gustavus E. C., 19, clerk—Shorthand (1st)
Goodale, Edward Jarvis, 47, clerk—Book-keeping (1st)
Graham, James, 23, schoolmaster—Book-keeping (2d); French (3d)
Greaves, Maud, 18 (no occupation stated)—Shorthand (3d)
Grindle, Ralph John Walter, 22 (no occupation stated)—Spanish (3d)
Gurling, Charles William, 16, clerk—Shorthand (3d)
Harrington, Emily M., 20, typist—Shorthand (1st)
Harrison, Sydney Thomas Walker, 19 (no occupation stated)—Shorthand (3d)
Harrison, William John, 19, shorthand clerk and typist—Shorthand (3d)
Hart, Edward, 18, clerk—Book-keeping (1st), and the Society's Bronze Medal
Havers, Florence Isabel, 16, shorthand writer and typist—Type-writing (1st); Shorthand (2d)
Hawkins, William Henry, 22, clerk—Shorthand (2d)
Haynes, Emily Frances, 23 (no occupation stated)—Book-keeping (2d)
Heath, George, 45 (no occupation)—Spanish (3d)
Heeson, Edward, 18, shorthand clerk—Shorthand (3d)
Henderson, Walter Henry, 17, clerk—Shorthand (3d)
Hicks, William F., 18 (no occupation)—Book-keeping (3d)
Higgs, George Thomas, 22, shorthand clerk—Shorthand (1st); and the Society's Bronze Medal
Hill, Henry, 19, reporter—Shorthand (2d)
Hill, Winifred Emma, 16, shorthand writer and typist—Type-writing (2d)
Hitchcock, Alice Maud, 17, typist—Type-writing (3d)
Hitchcock, Amy Althea, 16, typist—Type-writing (2d)
Hodd, Percival Charles, 16, scholar—Book-keeping (2d)
Hooper, Alfred Herbert, 30, clerk—Shorthand (2d)
Howard, Edith M., 24, stenographer—Type-writing (3d)
Howard, Tamar Ann, 36, type-writer—Type-writing (1st), and the Society's Bronze Medal
Hoyte, George Charles, 40 (no occupation stated)—Book-keeping (2d)
Hughes, Henry Joseph, 21, clerk—Shorthand (3d)
Hunt, Margaret L., 18 (no occupation stated)—Shorthand (2d)
Jarman, Beatrice, 18, type-writer—Type-writing (3d)
Jeffries, Charles David, 24, clerk—Shorthand (3d)
Jellicoe, George, 20, student—Shorthand (3d)
Johnson, Grace, 17, shorthand-writer—Book-keeping (3d); Shorthand (3d)
Kelly, Richard James, 20, clerk—Book-keeping (1st)
Kossenhaschen, G. A. F., 23, hotel *employé*—Book-keeping (1st)
Lacey, Tom, 27, clerk—Shorthand (3d)
Landells, Walter, 17, clerk—Shorthand (2d)
Leask, John, 21, clerk—Shorthand (2d)
Lewis, George Thomas, 17, clerk—Shorthand (2d)
Low, Percy Arthur, 17, clerk—Shorthand (3d)
Lycett, Howard Bellamy, 26, interpreter and book-keeper—Shorthand (3d)
McGregor, Ellen Gertrude, 21, clerk and type-writer—Type-writing (3d)
Mansfield, Edward John, 30, clerk—Book-keeping (2d)
May, Courtenay, 47, clerk — Book-keeping (2d)
Mayhew, H., 16, clerk—Shorthand (3d)
Mears, Walter Charles, 17, clerk—Shorthand (3d)
Minns, Edith, 23, clerk and type-writer—Type-writing (3d)
Moore, Thomas William, 22, clerk—Shorthand (3d)
Munro, Mary Christina Jane, 18, clerk—Type-writing (3d)
Murrell, John Ernest, 21, clerk—Shorthand (3d)
Nelson, Greville Thomas, 16, clerk—Shorthand (2d)
Nind, Jessie, 18, pupil—Book-keeping (2d)
Norman, Walter Aston, 20, clerk—Shorthand (3d)
Northcott, Richard A., 20, journalist—Shorthand (3d)
Nye, George, 18, commercial clerk—Shorthand (2d)
O Hara, Mary Alice, 15, apprentice to type-writing—Type-writing (2d)
Page, Frank, 20, clerk—Shorthand (2d)
Palmer, Herbert, 23, clerk—Book-keeping (2d)
Palmer, Walter Henry, 23, clerk—Shorthand (3d)
Partridge, Ernest Alfred, 20, clerk—Book-keeping (1st)
Pearse, David G., 22, clerk—Shorthand (1st)
Pemberton, James, 19, clerk—Shorthand (3d)
Philip, Philippa Maude, 25 (no occupation stated)—Shorthand (3d)
Pike, Edward, 25, teacher—Shorthand (1st)
Pope, Tom, 24, warehouseman—Spanish (2d)

Pring, Colin Spencer, 20, clerk—Shorthand (2d)
Randall, Frederick Richard, 19, shorthand clerk—Shorthand (3d)
Reeves, Percy Robert, 16, solicitor's shorthand clerk—Shorthand (1st)
Richardson, Josiah Sortain, 32, clerk—Shorthand (3d)
Roberts, Joseph, 30, drapery packer—Shorthand (3d)
Romanel, Netta Edith, 17, shorthand clerk and type-writer—Type-writing (1st)
Ross, William James, 18, student—Shorthand (3d)
Sarti, Ada, 22, clerk—Shorthand (3d)
Scaife, Arthur John, 15, shorthand clerk—Shorthand (3d)
Seal, Frederick John, 24, clerk—Type-writing (3d)
Sedgwick, Amy M., 20, clerk—Book-keeping (2d)
Shepherd, James, 24, shorthand clerk—Type-writing (1st)
Short, Lilian, 26 (no occupation stated)—Type-writing (2d); Shorthand (2d)
Short, Robert Frederick Withy, 23, clerk—Shorthand (2d)
Simmonds, Herbert S., 26 (no occupation stated)—Book-keeping (2d)
Smith, Ethel Bessie, 17, student—Shorthand (3d)
Smith, Ethel Blount, 16, shorthand writer and typist— Shorthand (2d)
Smith, John Tree, 17 (no occupation stated)—English (3d)
Smith, Stanley Pinching, 18, clerk—Shorthand (3d)
Snarey, Amy, 18, apprentice—Type-writing (3d)
Snowden, Harry 21, student—Book-keeping (1st)
Sowerby, Emily Kate, 26, student—Shorthand (3d); Book-keeping (2d)
Sparkhall, John Garibaldi, 25, clerk—Shorthand (2d)
Spier, Emily, 32 (no occupation stated)—Type-writing (2d)
Stanbridge, Archibald Robert, 19, shorthand clerk—Shorthand (1st)
Stapylton, Bryan, 21 (no occupation stated)—Shorthand (3d)
Stephens, William Joseph, 21, clerk—Book-keeping (2d)
Stephenson, Henry Percy, 24 (no occupation)—Book-keeping (1st)
Stevenson, James William, 14, clerk—Shorthand (3d)
Stokes, Thomas Charles, 19, clerk—Type-writing (3d)
Taylor, Martin, 23, clerk—Shorthand (3d)
Thomas, Henry George, 16 (no occupation)—Shorthand (3d)
Threadgold, John Ralph, 28, shorthand clerk—Book-keeping (3d)
Tow, Millicent Ashby, 22, shorthand writer and typist—Type-writing (1st)
Underwood, Herbert Charles, 20, shorthand teacher—Shorthand (2d)
Vipond, Charles Henry, 32, clerk—Shorthand (3d)
Walker, Stephen, 19, shorthand clerk—Shorthand (3d)
Waller, Henry William, 17, solicitor's cleik—Shorthand (1st), and the Society's Bronze Medal
Walmsley, William, 24, teacher—Book-keeping (1st); Shorthand (2d)
Watt, Cissey, 19, clerk—Shorthand (3d)
Watts, Arthur, 26, clerk—Shorthand (2d)
Westropp, Berkley George Gale, 16, clerk—Shorthand (3d)
Wharton, Elizabeth, 28, student—Book-keeping (2d)
Whiting, Alice Maud, 17, typist—Type-writing (2d)
Williams, Alice Verner, 26 (no occupation)—Book-keeping (2d)
Wilson, Emma Elizabeth, 17, student—Shorthand (3d)
Winkworth, Leonard Thomas, 15, clerk—Shorthand (3d)
Woodfine, Thomas F., 19, clerk—French (3d)
Wright, George A., 17, clerk—Book-keeping (2d)

LONDON (MILDMAY-PARK).

Brooks, Henry Charles Frederick, 21, storekeeper—Book-keeping (2d)
Brown, George William, 21, warehouseman—Book-keeping (3d)
Chapman, William Frederick, 26, warehouseman—Book-keeping (3d)
Crosweller, Herbert Charles, 30, storekeeper—Book-keeping (2d)
Goddard, Cecil Willie Drew, 18, clerk—Book-keeping (2d)
King, Alfred Robert, 18, milkman—Book-keeping (3d)
Marchant, John James, 22, baker—Book-keeping (3d)
Mead, William, 38, warehouseman—Book-keeping (2d)
Mitchell, Thomas, 19, brush-maker—Book-keeping (3d)
Sands, William Henry, 22, clerk—Book-keeping (2d)
Seymour, Albert E. 17, portmanteau maker—Book-keeping (3d)
Taylor, Henry, 25, labourer—Book-keeping (3d)

LONDON (PEOPLE'S PALACE, MILE-END).

Allen, Charles Edward, 20, shorthand clerk—Book-keeping (3d)
Ambrose, Effie, 20 (no occupation stated)—Book-keeping (2d)
Attwell, Annie Florence, 18 (no occupation stated)—Book-keeping (2d)
Auerbach, Albert, 20, book-keeper and correspondent—Book-keeping (2d)
Axford, Walter, 22, clerk—Book-keeping (3d)
Barlow, Mary Ann, 47, teacher—Domestic Economy (3d)
Bartlett, Henry Tufrey, 30, schoolmaster—Book-keeping (3d)
Bew, John Samuel, 23 (no occupation stated)—French (2d)

Bonson, Joseph, 27, teacher—Book-keeping (3d)
Bradley, F. G., 19, clerk—Book-keeping (3d)
Brown, Charles James, 20, clerk—Book-keeping (1st)
Campbell, T. Colin, 18, clerk—Book-keeping (3d)
Carr, Alice Blanche, 21, cashier and book-keeper—Book-keeping (2d)
Chapple, Ernest Raymond, 29, schoolmaster—Book-keeping (1st)
Chilcott, Alice, 27, teacher—French (1st)
Copeman, Percy James, 19, clerk—Book-keeping (3d)
Cossor, Florence Kate, 18 (no occupation)—Book-keeping (2d)
Curtis, Charles W., 22, clerk—Book-keeping (1st)
Davis, Harry Thomas, 18, clerk—Book-keeping (2d)
Dean, Mrs. H., 44 (no occupation stated)—French (1st)
Dent, Frederick Henry, 22, clerk—Book-keeping (1st)
Dew, John, 54, teacher—German (1st)
Dore, Ethel Maria, 18 (no occupation stated)—Book-keeping (3d)
Dousett, Charlotte E., 31, student—Book-keeping (2d)
Downs, Oliver Augustus, 39, teacher—Book-keeping (3d)
Elvin, Herbert Henry, 17, clerk—Book-keeping (2d)
Felgate John, 34, teacher,—Book-keeping (1st)
Fettes, David, 39, Inland Revenue officer—Book-keeping (2d)
Fullforde, Emily, 23, teacher—Book-keeping (2d)
Giles, Annie Isabella, 21 (no occupation)—Book-keeping (3d)
Green, Florence Amy, 21 (no occupation)—Book-keeping (2d)
Heather, Emily M. E., 38 (no occupation)—Domestic Economy (3d)
Hitchcock, John R., 24, clerk—Book-keeping (2d)
Holley, Elizabeth Myra, 28, assistant schoolmistress—Book-keeping (2d)
Hughes, Catherine Elizabeth, 21 (no occupation)—Book-keeping (3d)
Johnson, William, 19, clerk—Book-keeping (2d)
Kingsbury, Elizabeth, 37 (no occupation)—Domestic Economy (2d)
Lane, Cora Isabelle, 19, shorthand and typewriter—Book-keeping (3d)
Langan, John, 36, Inland Revenue officer—Book-keeping (2d)
Lindsay, Henry, 18, clerk—Book-keeping (2d)
Lines, Henry James, 21, grocer's assistant—Book-keeping (3d)
Marshman, William John, 35, clerk—Book-keeping (2d)
Mazengarb, George Alfred, 27, teacher—Book-keeping (2d)
Metson, Lydia, 16 (no occupation stated)—Book-keeping (2d)
Mitchell, George Joseph, 32, schoolmaster—Commercial Geography (3d)
Moody, Emily, 14 (no occupation)—Book-keeping (3d)
Moyses, Laura Rebecca, 23, assistant mistress—Book-keeping (3d)
New, Frederick, 23, clerk—Book-keeping (1st)
Newport, Arthur, 17, clerk—Book-keeping (2d)
Notman, William Chas., 18, clerk—Book-keeping (3d)
Parsons, Henry J., 21, clerk—Book-keeping (2d)
Pettersson, Augusta Caroline Henrietta, 25, teacher—Book-keeping (2d)
Phipps, Henry Charles, 14, clerk—Book-keeping (3d)
Pleasants, Arthur George, 20, clerk—Book-keeping (2d)
Poulter, Thomas Frederick, 20, draper's assistant—Book-keeping (3d)
Purton, Henry, 19, clerk—Book-keeping (3d)
O'Dwyer, Patrick, 39, Inland Revenue officer—Book-keeping (2d)
Richardson, Georgina, 30, schoolmistress—Domestic Economy (2d)
Ridge, John, 31, teacher—Book-keeping (3d)
Rolfe, Emily, 31 (no occupation stated)—Book-keeping (3d)
Sarfas, Frederick, 27, teacher—French (3d)
Saville, Benjamin Robert, 23, clerk—Book-keeping (3d)
Sessel, Lewis Ernest, 18 (no occupation)—Book-keeping (2d)
Starkey, Rosina Elizabeth Mary, 25, assistant mistress—Book-keeping (2d)
Sutton, Alfred Henry, 19, clerk—Book-keeping (2d)
Tanner, Katherine, 20, clerk—Book-keeping (1st)
Thomas, Sarah, 42, governess—French (1st)
Tofts, Jane Harriet, 18 (no occupation)—Book-keeping (2d)
Underwood, Winifred, 20 (no occupation stated)—Book-keeping (3d)
Walker, Edward Henry, 28, teacher—Book-keeping (3d)
Wallace, Robert John, 30, teacher—Book-keeping (2d)
Weeden, James William, 21, clerk—Book-keeping (2d)
Whitbread, Dinah J., 37, schoolmistress—Domestic Economy (3d)
Whitehead, Charles J., 19, clerk—Book-keeping (3d)
Wignall, Ernest John, 17, clerk—Book-keeping (2d)
Willis, Charles Reeves, 18, clerk—Book-keeping (3d)
Wood, Joseph Henry, 19, clerk—Book-keeping (1st)
Young, Alfred William, 23, clerk—Book-keeping (1st)

LONDON (POPLAR SCHOOL OF MUSIC).

Bain, Richard Thomas, 20, student—Theory of Music (2d)
Clarke, Ellen Lydia, 26 (no occupation)—Theory of Music (2d)

LONDON (SCHOOL BOARD).

Archer, Charles Henry Thomas, 29, clerk—Book-keeping (3d)
Ascott, Frederick, 25, teacher—Shorthand (3d)
Ashton, Clara, 19, pupil teacher—Domestic Economy (2d)
Bale, John, 34, teacher—Book-keeping (3d)
Barnes, Helen Catherine, 22 (no occupation stated)—Book-keeping (3d)
Barrey, M. Maude, 19, pupil teacher—Domestic Economy (2d)
Barry, Edward Smith, 27, teacher—Book-keeping (2d)
Bartlett, Frederick William, 29, teacher—Book-keeping (2d)
Baseden, Thomas, 29, schoolmaster—Book-keeping (3d)
Bayley, Samuel, 27, teacher—Book-keeping (2d)
Beaumont, Gertrude Maude Neva, 18, teacher—Domestic Economy (3d)
Blincko, Louise, 19, teacher—Domestic Economy (3d)
Brawn, Edith, 18, pupil teacher—Domestic Economy (1st)
Burton, William, 33, teacher—Book-keeping (3d)
Clay, Lewis, 24, assistant master—Book-keeping (2d)
Coleman, Margaret Isabelle, 25, teacher—Book-keeping (3d)
Colthrup, Charles William, 19, clerk—Book-keeping (1st)
Cosnett, Henry, 27, schoolmaster—Book-keeping (3d)
Costello, John Joseph, 24, teacher—Shorthand (3d)
Crook, Annie Florence, 19, pupil teacher—Domestic Economy (2d)
Dames, Arthur Russell, 27, schoolmaster—Book-keeping (3d)
De la Bertouche, Robert, 27, teacher—Book-keeping (2d)
Dixon, Edgar John, 26, schoolmaster—Book-keeping (3d)
Dixon, Jane Ellen, 18, pupil teacher—Domestic Economy (2d)
Doble, Arthur Robert, 35, teacher—Book-keeping (2d)
Eddleston, Edward, 27, teacher—Book-keeping (2d)
Eyles, Edward, 25, schoolmaster—Book-keeping (2d)
Fennall, Frederick John, 30, schoolmaster—Book-keeping (2d)
Forrest, John, 31, schoolmaster—Shorthand (2d)
Gibbard, Arthur, 32, schoolmaster—Book-keeping (2d)
Gilby, Blanche, 19, pupil teacher—Domestic Economy (2d)
Gilby, Walter Hargett, 26, schoolmaster—Book-keeping (2d)
Greig, James, 23, teacher—Book-keeping (3d)
Grimson, George Charles, 29, schoolmaster—Book-keeping (3d)
Guy, Robert G., 16, clerk—Book-keeping (2d)
Haddy, Alfred John, 23, teacher—Book-keeping (3d)
Harris, Samuel Claude, 28, teacher—Book-keeping (3d)
Hicks, Edith Florence, 19, pupil teacher—Domestic Economy (2d)
Hill, Thomas Dunstan, 31, teacher—Book-keeping (3d)
Hoad, Alice, 18, pupil teacher—Domestic Economy (2d)
Housecroft, Harry, 29, teacher—French (3d); Book-keeping (2d)
Howlett, Louisa Emily, 39, teacher—Book-keeping (2d)
Humm, Albert F. W., 27, schoolmaster—French (3d)
Husband, Florence Elizabeth, 25, assistant-mistress—Book-keeping (3d)
Jacobs, William, 23, teacher—Book-keeping (2d)
James, Alfred Chalk, 33, schoolmaster—Book-keeping (3d)
Jenkins, Henry, 34, teacher—Shorthand (3d)
Jennings, John, 56, schoolmaster—Book-keeping (2d)
Johnson, Alfred Joseph, 32, schoolmaster—Book-keeping (2d)
Keast, Florence, 18 (no occupation)—Book-keeping (2d)
Kent, William, 37, schoolmaster—Book-keeping (3d)
Kettle, Ella May 19, (no occupation stated)—Book-keeping (2d)
Lane, George, 50, schoolmaster—Book-keeping (3d)
Lawson, Marianne, 30, teacher—Book-keeping (2d)
Lovell, Frederick Joseph, 25, teacher—Book-keeping (2d)
McDermott, William, 29, teacher—French (3d)
McKissock, Andrew, 29, teacher—Book-keeping (3d)
Maltby, Jane Harriet, 41, schoolmistress—French (3d)
Marsh, Emily Annie, 19, pupil teacher—Domestic economy (3d)
Mather, Jessie Emma, 31, teacher—Book-keeping (3d)
Maybrook, Walter Richard, 24, teacher—Book-keeping (3d)
Millis, Alfred Ernest, 30, schoolmaster—Book-keeping (2d)
Minnion, Henry John, 31, teacher—Book-keeping (2d)
Murrison, James, 30, teacher—Book-keeping (3d)
Oliver, Edward L., 40, teacher—Book-keeping (3d)
Osborn, Thomas William, 30, schoolmaster—Book-keeping (2d)
Page, Herbert E., 23, teacher—Book-keeping (2d)
Pascoe, William Henry, 25, schoolmaster—Book-keeping (3d)
Phillimore, William, 47, teacher—French (3d)
Plank, Kate Louise, 30, teacher—French (3d)

Pooley, Mary Jane, 31, teacher—Book-keeping (2d)
Potter, Ebenezer, 51, teacher—Book-keeping (3d)
Prebble, Edwin, 31, teacher—Book-keeping (3d); French (2d)
Price, Edwin George, 28, schoolmaster—Book-keeping (3d)
Privett, Frank, 38, teacher—Book-keeping (2d)
Rendell, Ernest Alfred, 25, teacher—Book-keeping (2d)
Robertson, Horatio Vincent, 25, clerk—Book-keeping (1st)
Ross, Jessie Emma, 25, schoolmistress—Book-keeping (2d)
Rossiter, Sidney, 22, teacher — French (3d)
Rowan, Joseph Patrick, 32, clerk—Book-keeping (1st)
Rutter, William Ulysses, 27, teacher—Book-keeping (2d)
Ryder, John Staddon, 19, clerk—Book-keeping (2d)
Saunders, Annie Louisa, 26, schoolmistress—Book-keeping (3d)
Saunders, Eliza, 19, pupil teacher—Domestic Economy (3d)
Schofield, Ellen Mary, 30, teacher—French (3d)
Scotton, Henry John, 25, teacher—Book-keeping (3rd)
Spary, Alfred Horace, 32, schoolmaster—Book-keeping (2d)
Standen, John Burden, 22, schoolmaster—French (3d)
Straw, Philip, 32, teacher — Book-keeping (1st)
Sutcliffe, Louise, 18, pupil teacher—Domestic Economy (2d)
Talbot, Arthur Hugh, 25, schoolmster—Book-keeping (3d)
Thompson, James, 29, student—Book-keeping (2d)
Thrift, Charles Richard, 28, teacher—Book-keeping (2d)
Timms, William Lowe, 27, assistant master—Book-keeping (3d)
Tossell, Michael Wm., 30, teacher—Book-keeping (2d)
Turner, Evelyn Mary, 19, pupil teacher—Domestic Economy (3d)
Tyler, John William, 47, teacher—Book-keeping (2d)
Waring, George Augustus, 33, schoolmaster—Book-keeping (3d)
Warren, Charles Thornton, 25, teacher—Book-keeping (3d)
Williams John James, 28, teacher—French (2d)
Williams, Thomas, 35, teacher—Book-keeping (3d)
Willis, Arthur John, 31, teacher—Book-keeping (1st)
Willson, John Edwin, 14, clerk—Book-keeping (2d)
Wootton, Edward, 28, teacher—Book-keeping (2d)
Wright, Frank, 27, schoolmaster — Book-keeping (1st)

LONDON (UNITED WESTMINSTER SCHOOLS).

Chaplin, Bernard George, 13, scholar—Arithmetic (3d)
Chilton, Herbert Richard, 13, scholar—Arithmetic (3d)
Fryer, Thomas Claude, 15, scholar—Arithmetic (3d)
Harrison, William, 15, scholar—Arithmetic (3d)
Hill, Emily, 38, teacher—Book-keeping (3d)
Lance, Octavius, 15, clerk—Book-keeping (2d)
Mackness, Herbert Dunton, 16, scholar—Theory of Music (3d)
Maslin, Charles James, 15, scholar—Arithmetic (3d)
Parker, Ernest Charles, 16, scholar—Arithmetic (3d)
Quennell, Alec William, 14, scholar—Arithmetic (3d)
Rand, Charles Herbert, 15, scholar—Arithmetic (3d)

LONDON (WESTBOURNE-PARK INSTITUTE).

Ashford, Elizabeth Catherine, 21, pupil-teacher—Book-keeping (3d)
Green, Christina, 21 (no occupation stated)—Book-keeping (3d)

LONDON (WESTMINSTER TECHNICAL INSTITUTE).

Ball, Clarence Reginald, 19, clerk—Book-keeping (2d)
Coates, Susannah May, 16 (no occupation)—English (3d); Book-keeping (2d)
Green, Frederick C., 19, clerk—Book-keeping (2d)
Hill, Lissie Emma, 19, teacher — Domestic Economy (2d)
Jefferis, Ada Agnes, 14, scholar—Domestic Economy (3d)
Lees, William Powlson, 24, clerk — French (3d)
Potter, Inna, 23, teacher—Domestic Economy (2d)
Rembges, Mina, 20, vellum - sewer—Book-keeping (2d)
Robinson, Francis William, 13, scholar—Book-keeping (3d)
Wilkins, Benjamin William Trident, 31, clerk—Shorthand (3d)

LONDON (YOUNG MEN'S CHRISTIAN ASSOCIATION, EXETER HALL).

Burgess, Harriette Alice, 35, teacher—Book-keeping (3d)
Cane, Henry, 17, clerk—Book-keeping (3d)
Dance, Minnie Louisa, 25, teacher—Book-keeping (2d)
Evans, Thomas, 32, clerk—Book-keeping (2d)
Gates, Ernest Samuel, 31, teacher—Book-keeping (3d)
Hicks, John, 27, teacher—Book-keeping (3d)
Kopp, Alfred I., 29, teacher—Book-keeping (2d)

Leigh, Eusebius, 34, schoolmaster—Book-keeping (2d)
Lonnie, Kate Janet, 20 (no occupation stated)—Book-keeping (3d)
Macphail, Peter, 28, clerk—Book-keeping (3d)
Pryce, Ellen E., 22, teacher—Book-keeping (2d)
Ray, Sidney Herbert, 33, schoolmaster—Book-keeping (3d)
Shepherd, James, 24, shorthand clerk—Book-keeping (3d)
White, Mary, 40, teacher—Book-keeping (2d)
Wilson, George Frederick, 24, clerk—Book-keeping (3d)

LONDON (YOUNG MEN'S CHRISTIAN INSTITUTE, POLYTECHNIC).

Abrahams, Louis, 14, scholar—German (3d); Book-keeping (3d)
Apted, Alice Louise, 15 (no occupation)—Book-keeping (2d)
Austin, Lilian, 21, assistant—Book-keeping (3d)
Bailey, Henry Christopher, 14 (no occupation)—English (3d)
Baker, Cyril H., 15, scholar—English (3d)
Bales, William James, 22, warehouseman—Bookkeeping (3d)
Barnett, Percy David, 14, scholar—Book-keeping (3d)
Beadle, Hugh, 23, clerk—Book-keeping (2d)
Bennetto, Albert Edward, 29, cashier—Theory of Music (2d)
Berry, Alice, 27, book-keeper—Book-keeping (1st)
Brooking, Albert George, 17, clerk—Book-keeping (3d)
Brown, Louisa Maria, 23, (no occupation stated)—Book-keeping (3d)
Burley, Stuart James, 17, bankers' apprentice—Book-keeping (3d)
Burwood, Alice Emily, 23, clerk—Book-keeping (2d)
Butler, Thomas Charles, 24, draughtsman—English (3d)
Carter, Edwin, 25, draughtsman—English (2d)
Chandler, Lottie, 16 (no occupation stated)—Book-keeping (3d)
Charles, Caroline Ann, 22 (no occupation stated)—Book-keeping (3d)
Cochrane, Robert Oliver, 15, scholar—Book-keeping (2d)
Collins, Florence, 21 (no occupation stated)—Book-keeping (3d)
Coop, Florence, 18, outfitter—Book-keeping (3d)
Dale, Kathleen, 27 (no occupation)—Book-keeping (2d)
Darley, George Edward Davidson, 18, clerk—Book-keeping (2d)
Davis, Maria, 20, teacher—German (3d)
Debenham, Harry Edgar, 23, clerk—Book-keeping (2d)
Dent, Alice, 18, cashier—Book-keeping (3d)
Diggins, Clara, 19, clerk—Book-keeping (2d)
Edwards, Mary, 24, clerk—Shorthand (3d)
Elven, Minnie, 22 (no occupation stated)—Book-keeping (2d)
Felton, Mary Ann, 16 (no occupation stated)—Book-keeping (3d)
Gardner, Amelia, 23, clerk—Book-keeping (2d)
Gatrell, Ada Louise, 27 (no occupation stated)—Book-keeping (3d)
Gimbert, Thomas William, 27, clerk—Shorthand (1st); English (2d); Book-keeping (3d)
Halliday, George Herbert, 15, clerk—Book-keeping (3d)
Hastings, Frank, 24, shorthand-writer—Type-writing (3d)
Healy, J. G., 16, clerk—Shorthand (3d)
Hill, Benjamin H., 22, clerk—Book-keeping (3d)
Hill, Henry Grenville, 24, shorthand clerk—Type-writing (3d)
Hill, Rowland Talbot, 26, clerk—Shorthand (1st)
Hiscock, Alfred Richard, 15, student—Book-keeping (3d)
Hobbs, Sarah Ansley, 26, teacher—Book-keeping (3d)
Innous, Thomas James, 24, clerk—Theory of Music (2d)
James, Edgar Llewellyn, 14, scholar—Book-keeping (3d); German (3d)
Johnson, Bertram, 17 (no occupation stated)—Shorthand (3d)
Jones, Edith Ellen, 16 (no occupation stated)—Book-keeping (2d)
Kellond, Mildred Alice, 14 (no occupation stated)—Book-keeping (3d)
Kirkup, Thomas Henry, 28, clerk—Book-keeping (3d)
Lambley, Victor Begent Forester, 31, clerk—Shorthand (1st)
Land, Mary Alvenia, 25, clerk—Book-keeping (3d)
Leadsom, John Roughby, 18, shorthand typist—Book-keeping (2d)
Liddington, Ezra William Edmund, 15, scholar—Book-keeping (1st)
Linnett, Amy, 23, compositor—German (3d)
Maggs, Ernest Uriah, 15, scholar—Book-keeping (3d)
Marshall, Eleanor, 23, teacher—English (1st); Domestic Economy (1st)
Marshall, Jessie Charlotte, 24 (no occupation stated)—Book-keeping (3d)
Mudge, Herbert H., 19, clerk—Book-keeping (1st)
Northcroft, May, 19 (no occupation stated)—Book-keeping (3d)
O'Connor, Vincent, 15, pupil teacher—English (2d)
Oehlman, William, 26, tailor—German (2d)
Pain, Laura, 18, (no occupation stated)—Book-keeping (2d)
Parslow, Agnes M., 24 (no occupation stated)—Book-keeping (3d)
Poole, Richard Edwin, 14 (no occupation)—Book-keeping (2d); Arithmetic (3d)
Pritchett, Herbert, 25, clerk — Shorthand (3d)
Radford, John Arthur Richardson, 23, clerk—Book-keeping (2d)
Ramsden, Thomas, 22, clerk—Book-keeping (2d); Type-writing (2d)

Ross, Kate S., 24 (no occupation stated)—Book-keeping (2d)
Shepherd, William Percy, 15, scholar—Arithmetic (1st); Book-keeping (1st)
Smith, H. Nelson, 17, clerk—German (1st)
Smith, Paul Conway, 27, teacher—English (1st)
Stanton, Walter, 16, clerk—Book-keeping (2d)
Stephenson, Isabel Harriet, 34, rent collector—Book-keeping (3d)
Stranack, Herbert E., 20, correspondent—German (2d)
Taffe, Annie, 17, milliner—Book-keeping (3d)
Tassie, George Augustus, 20, clerk—Book-keeping (3d)
Taylor, Emily, 15 (no occupation stated)—Book-keeping (3d)
Thomas, Lewis, 19, clerk—Book-keeping (3d)
Thomson, William Alfred, 29, teacher—Shorthand (3d)
Thurley, Frederick, 21, clerk—Book-keeping (2d)
Tournu, Charles Ernest, 16, scholar—Arithmetic (3d)
Vane-Thomas, Florence Adèle Annie, 17, scholar—Book-keeping (3d)
Vokes, William, 25, publisher—English (2d)
Wentworth, Darsie, 22, clerk—German (2d)
Wilkinson, William, 19, clerk—German (3d)
Wilson, Christopher, 23, correspondent—German (2d)
Wilson, Edith, 18, saleswoman—Book-keeping (3d)
Wolff, Adolphe, 57, teacher—French (2d); Spanish (1st)
Wolfsberger, Emil Anton, 21, clerk—English (3d)
Woolcot, Florence Edith, 18, dressmaker—English (3d)
Wrenn, Norman Edwin, 19, shorthand clerk—Shorthand (3d)
Wright, Herbert Edgar, 18, clerk—Shorthand (3d)

LUTON.

Blackburn, Francis J., 19, clerk—Book-keeping (2d)
Cobbald, Alice, 27, dairy mistress—Book-keeping (3d)
Crewe, Bernardo Thomas, 23, clerk—Book-keeping (2d)
Swain, Edward Henry, 21, clerk—Book-keeping (2d)

MANCHESTER (LOWER MOSLEY STREET SCHOOLS).

Abrahams, George Henry, 20, clerk—Book-keeping (2d)
Alger, Henry, 16, clerk—Shorthand (3d)
Altman, Joseph, 16, scholar—Book-keeping (3d)
Archer, Thomas Henry, 22, clerk—Book-keeping (2d)
Arrowsmith, William, 20, clerk—Theory of Music (2d); Book-keeping (2d)
Barnes, Edwin, 28, clerk—Book-keeping (3d)
Barnes, Samuel, 15, clerk—Shorthand (3d)
Barrow, George, 16, clerk—Shorthand (3d)
Baxter, John, 39, schoolmaster—Shorthand (3d)
Bennett, Lily, 19 (no occupation)—Theory of Music (3d)
Beswick, Thomas, 19, clerk—Book-keeping (1st)
Booth, Charles Henry, 27, clerk—Shorthand (3d)
Bretherton, Mary Vaughan, 17, typist—Type-writing (2d)
Brown, George William, 20, stationer—Book-keeping (3d)
Burrows, John Charles, 26, clerk—Theory of Music (2d)
Butterworth, Fred, 17, clerk—Book-keeping (2d)
Carpenter, Nellie, 15, typist—Type-writing (3d)
Clague, Stanley, 21, clerk—Type-writing (3d)
Coates, Florence Emilie, 18, telephone operator—Book-keeping (3d)
Connor, Edward, 20, clerk—Book-keeping (2d)
Corker, James Shelmerdine, 17, clerk—Shorthand (3d)
Crain, Charles, 27, pianist—Theory of Music (1st)
Darbyshire, Egbert, 23, clerk—Shorthand (3d)
Dichmont, James, 18, clerk—Shorthand (3d)
Dickinson, Luther, 17, clerk—Shorthand (3d)
Drescher, Frederick, 28, clerk—Shorthand (3d)
Driver, Harry Heywood, 16, clerk—Shorthand (2d)
Ferguson, James, 17, invoice clerk—Shorthand (3d)
Fleming, Joseph Griffiths, 18, pattern-card maker—Shorthand (3d)
Foster, Walter Edwin, 23, dairyman—Shorthand (3d)
Foy, William, 19, clerk—Shorthand (1st)
Furness, Alice, 19, type-writer—Type-writing (3d)
Gee, William Henry, 22, salesman—Theory of Music (3d)
Grime, Arthur, 17, clerk—Shorthand (2d)
Hague, John Cecil, 21, teacher—Shorthand (2d)
Harper, William, 19, solicitor's clerk—Book-keeping (3d)
Harrison, Thomas Frederick, 21, assurance clerk—Type-writing (3d)
Harrop, John William, 33, lamplighter—Shorthand (3d)
Heap, Harry, 18, clerk—Shorthand (3d)
Heywood, Ethel, 16, type-writer—Type-writing (3d)
Hirst, Thomas, 18, clerk—Shorthand (3d)
Howarth, James Greenhalgh, 17, commercial traveller—Shorthand (3d)
Ianson, Joseph Herbert, 16, clerk—Shorthand (3d)
Ireland, Albert, 18, clerk—Book-keeping (3d)
Ireland, John Edward, 20, salesman—Book-keeping (1st)
Irving, George John, 19, salesman—Book-keeping (3d)
Jackson, Robert Holmes, 15, clerk—Shorthand (3d)
Johnson, Charles, 24, draughtsman—Theory of Music (3d)
Kelly, Henry M., 21, clerk—Shorthand (2d)

Kennedy, Maggie Gertrude, 19, typist—Type-writing (2d)
Kidd, Henry, 22, clerk—Spanish (1st); German (2d)
Kinsey, Peter, 19, pupil teacher—Shorthand (1st)
Lane, Joseph Pugh, 13 (no occupation stated)—Theory of Music (3d)
Lindley, Alfred Clarke, 20, printer—English (3d)
Luckhurst, Percival, 21, clerk—Theory of Music (3d)
McCaull, David, 19, clerk—Shorthand (3d)
Menzies, James Conchie, 17, clerk—Shorthand (2d)
Moffit, John Holliday, 16, clerk—Shorthand (3d)
Moss, Frederick, 19 (no occupation stated)—Theory of Music (3d)
Mountain, Ada M., 17, typist—Type-writing (2d)
Mountain, Annie Emily, 22, typist—Type-writing (1st)
Munro, George, 20, clerk—Book-keeping (3d)
Needham, James, 16, clerk—Shorthand (3d)
Oakes, Charles, 16, typist—Shorthand (3d)
Ogden, James Alfred, 16, clerk—Book-keeping (3d)
Owen, John William, 19, clerk—Shorthand (3d)
Partington, Wm., 25, clerk—Shorthand (2d)
Perry, Thomas, 21, warehouseman—Shorthand (3d)
Platt, George Starr, 21, clerk—Shorthand (3d)
Povey, Walter William, 21, clerk—Shorthand (3d)
Rigby, Louie Tunstall, 23, teaching—Book-keeping (2d)
Rollinson, Joseph, 16, clerk—Shorthand (3d)
Rotheram, Annie Syms, 25 (no occupotion stated)—Theory of Music (3d)
Royles, John, 23, beamer—Book-keeping (3d)
Ryder, Walter, 22, clerk—Book-keeping (3d)
Scott, Annie Ethel, 17 (no occupation stated)—Theory of Music (3d)
Seddon, Joseph, 20, warehouseman—Shorthand (2d)
Shilton, Daniel, 25, assistant—Book-keeping (3d)
Shotton, William Boden, 24, clerk—Shorthand (3d)
Smith, Henry, 22, book-keeper—Shorthand (2d)
Stewart, Robert, 18, clerk—Book-keeping (3d)
Strong, John, 16, clerk—Shorthand (3d)
Taylor, William, 16, clerk—Shorthand (3d)
Trow, Arthur, 18, clerk—Shorthand (3d)
Twelves, Frederick Johnson, 17, clerk—Shorthand (3d)
Warburton, William, 26, clerk—Theory of Music (1st)
Wilson, Herbert Smith, 18, clerk—Shorthand (1st)

MANCHESTER (SCHOOL BOARD).

Abbott, Fred, 23, clerk—German (1st)
Ainley, Frederick Musgrove, 20, clerk—Book-keeping (1st)
Aldred, John Carter, 29, accountant—Spanish (3d)
Aldred, Thomas Crowther, 30, clerk—Book-keeping (2d)
Allsop, Tom, 18 (no occupation stated)—Book-keeping (3d)
Anderson, Lindsay, 14, scholar—Book-keeping (2d)
Appleton, Joseph, 28, salesman—Spanish (1st)
Aston, James, 24, salesman—Spanish (3d)
Baden, Andrew Percival, 18, clerk—Book-keeping (2d)
Barber, Elijah, 37, clerk—Shorthand (1st)
Barker, James Gaskell, 20, traveller and salesman—Book-keeping (2d)
Barnett, Joseph Albert, 17, clerk—German (3d)
Barrett, William Foulds, 23 (no occupation stated)—Book-keeping (3d)
Battye, James Taylor, 14, scholar—Book-keeping (3d)
Beaumont, Harry, 16, clerk—Book-keeping (3d)
Bee, William Robert, 23, clerk—Book-keeping (1st)
Bell, Charles Moore, 27, teacher—Book-keeping (3d)
Bellis, William Ewart, 17, clerk—Shorthand (3d)
Bent, Mable, 16 (no occupation stated)—Book-keeping (3d)
Berry, Joseph, 15, clerk—Book-keeping (2d)
Betley, James Edward, 24, buyer—Spanish (3d)
Birch, Frederick Y., 25, clerk—Book-keeping (1st)
Bird, Laura, 22, cashier—French (3d)
Black, Arthur Grave, 21, clerk—Book-keeping (2d)
Black, George Boyd, 25, clerk—Book-keeping (3d)
Blake, George Stanfield, 15, scholar—Book-keeping (3d)
Boardman, William, 18, clerk—Book-keeping (1st)
Boon, Gertrude E., 22, student—English (2d)
Boon, Mabel, 20, student—English (2d)
Bowker, Thomas, 21, clerk—Book-keeping (3d)
Boyd, Amy, 17, scholar—Book-keeping (3d)
Bradbury, Charles Holford, 21, clerk—Book-keeping (3d)
Bradshaw, Harry Greaves, 20, civil engineer's pupil—Book-keeping (2d)
Bridge, Frederic Robert, 15, scholar—Book-keeping (2d)
Bridge, Herbert Armitage, 18, clerk—Shorthand (2d)
Brisbane, John William, 23, clerk—Book-keeping (1st)
Broughton, Thomas, 37, chemist's assistant—Spanish (2d)
Brown, Ernest William, 19, clerk—Book-keeping (2d); Shorthand (2d)
Budge, Frederick Henry, 22, clerk—Spanish (3d)
Bullough, Florence, 14, scholar—Book-keep-keeping (2d)
Burgess, Mary, 16, scholar—Book-keeping (1st)
Burrows, Ernest Edward, 19, book-keeper—Book-keeping (2d)

Burton, Wallace, 16, student—Book-keeping (2d)
Butterworth, Frank, 13, scholar—Book-keeping (3d)
Calvert, Alfred, 33, clerk—Portuguese (1st), the Society's Bronze Medal, and the City Company's First Prize of £3; French (1st); Italian (1st)
Carter, Walter Traviss, 17, student—Book-keeping (3d)
Cartland, Reuben, 21, warehouseman—Book-keeping (3d)
Chapman, Charles, 21, student—Arithmetic (3d); English (2d); Shorthand (3d)
Chapman, William Henry, 32, clerk—Spanish (3d)
Charlton, James, 19, clerk—Book-keeping (2d)
Chorlton, Edwin A,, 15, scholar — Book-keeping (2d)
Churley, Ada Marion, 16, scholar—English (2d)
Clarke, Arthur Ebenezer, 32, insurance agent —Book-keeping (2d)
Clarke, Henry Wallace, 21, printer—German (1st); English (3d)
Clegg, William, 24, schoolmaster—Arithmetic (2d); English (1st)
Cliffe, Frederick Arthur, 24, clerk—Book-keeping (3d)
Collinge, Robert Edward, 22, clerk—Book-keeping (1st)
Collyns, Fred, 21, clerk—French (1st)
Crocker, Ernest, 15, clerk—Book-keeping (3d)
Croft, Walter, 15, clerk—Book-keeping (2d)
Croft, William Henry, 19, salesman—Arithmetic (3d); Commercial Geography (1st)
Crowder, Walter Clarence, 20, clerk—Spanish (2d)
Dakin, John Edward, 19, solicitor's clerk—Shorthand (3d)
Dalgliesh, Percy, 20, clerk—Spanish (2d)
Darrah, Hartley, 17, clerk—Book-keeping (3d)
Dawson, James, 16 (no occupation stated)—Book-keeping (2d)
Deakin, Florence, 15, scholar—Book-keeping (2d)
Dean, Tom, 14, scholar—Book-keeping (3d)
Dunkerley, James, 22, clerk—Book-keeping (1st)
Ellison, Cornelius, 20, clerk—Book-keeping (1st)
Ellison, Frederick, 22, clerk—Book-keeping (1st); Commercial Geography (3d)
Ernill, Arthur, 20, clerk—Book-keeping (2d)
Ernill, Fred, 22, salesman—Book-keeping (3d)
Ernill, James Henry, 27, clerk—Book-keeping (2d)
Fairhurst, John Robert, 22, clerk—Book-keeping (3d); Shorthand (2d)
Farrell, Frank James, 14, scholar—Book-keeping (2d)
Faux, William A., 20, clerk—Book-keeping (2d)
Fenton, James, 23, clerk—Type-writing (3d)
Fergusson, Helen C. F., 18, shop assistant—Book-keeping (1st)
Fidler, John Nathan, 22, clerk—Shorthand (3d)
Files, James, 13, scholar—Book-keeping (2d)
Fish, Ellen, 15, scholar—Book-keeping (3d)
Fisher, Charles Henry, 14, scholar—Book-keeping (3d)
Fitzpatrick, John, 15, scholar—Book-keeping (3d)
Floweth, Walter, 24, clerk—Spanish (1st), and the Clothworkers' Company's Second Prize of £2; German (1st); French (1st)
Foulkes, Thomas, 32, warehouseman—Book-keeping (2d)
Fox, Frank, 15, scholar—Book-keeping (3d)
Fulder, Frederick, 14, clerk—Book-keeping (3d)
Garnett, Sidney Robertson, 14, scholar—Book-keeping (3d)
Gibson, William Yates, 21, clerk—Book-keeping (2d)
Glenn, William, 19, clerk — Book-keeping (2d); Shorthand (3d)
Gordon, Ritchie, 16, scholar—English (3d)
Goring, Henry, 22, clerk—Book-keeping (2d)
Gregory, James, 29, clerk—Book-keeping (3d)
Gregory, Louis E. 27, teacher—English (2d); Arithmetic (3d)
Grime, Albert H., 24, tea-salesman—Book-keeping (3d)
Grimes, Wilfrid, 14, scholar—Book keeping (3d)
Hall, Joseph, 19, clerk—Book-keeping (2d)
Hall, Robert Musgrave, 30, teacher—Book-keeping (2d)
Hammond, Fanny, 19, type-writer—Type-writing (2d); Shorthand (3d)
Hampson, Walter Edgar, 19, clerk—Book-keeping (1st)
Hampson, W. A., 21, clerk—Book-keeping (1st)
Harding, Charles Fitton, 19, clerk—Spanish (1st)
Hargrave, Walter, 21, clerk—Book keeping (1st)
Hartley, John, 22, warehouseman — Book-keeping (3d)
Havelock, John Henry, 15, scholar—Book-keeping (2d)
Hayes, Harold, 20, print looker — Book-keeping (3d)
Heatley, Robert, 31, accountants' clerk—Book-keeping (1st)
Hibbert, H., 14, scholar—Book-keeping (2d); German (3d)
Hibbert, Isaac, 16, clerk—Book-keeping (2d)
Hockmeyer, Herman, 38, cashier—Spanish (1st)
Hodgson, Christopher, 14, scholar—Book-keeping (3d)
Hodgson, Minnie, 19, type-writer—Shorthand (3d)
Hodson, Robert, 30, clerk—English (2d); Arithmetic (3d)
Hoffman, Emilie, 22, governess—French (2d); German (1st)
Hoffman, Louisa, 27, governess — German (1st); English (1st)
Holland, Louisa, 31, teacher—German (3d)
Holmes, Fred, 22, warehouseman — Book-keeping (3d)
Holmes, Frederick, 19, clerk—Shorthand (1st); Book-keeping (1st)
Howard, Amos, 23, clerk—Book-keeping (2d)

Howard, Ernest, 17, clerk—Book-keeping (2d); Shorthand (3d)
Hynes, James, 29, teacher—Shorthand (2d)
Jackson, Charles Arthur, 17, clerk—Shorthand (2d)
Jackson, James, 20, clerk—Book-keeping (2d)
Jewitt, James Shovelton, 29, clerk—Shorthand (1st)
Jones, John David, 23, clerk—Book-keeping (2d)
Lambert, William James, 20, clerk—Shorthand (3d)
Lawton, Jessie, 25 (no occupation stated)—French (3d)
Lee, Herbert, 13, clerk—Book-keeping (2d)
Lees, Joseph, 24, clerk—Book-keeping (1st) and the Society's Bronze Medal
L'Estrange, James E., 31, clerk—Book-keeping (1st); Commercial Geography (2d)
Lloyd, Frederic, 27, designer—Book-keeping (3d)
Lord, James Thomas, 27, clerk—Book-keeping (2d)
Low, Arthur Rylands, 18, articled to chartered accountant—Book-keeping (1st)
Lowry, John A., 21, salesman—Spanish (2d)
McConnell, Ernest, 22, clerk—Book-keeping (3d)
McCullagh, Amy, 18, typist—Shorthand (3d)
McLellan, Hercules, 19, clerk—Book-keeping (2d)
McLellan, Walter, 17, clerk—Book-keeping (3d)
McMurray, Robert, 19, sawyer—Book-keeping (3d)
McWalter, John William, 23, clerk—Book-keeping (2d)
Marchanton, Frederick, 21, clerk—Book-keeping (1st)
Marsden, Mary Louisa, 25, draper's assistant—Commercial Geography (3d)
Marrs, James, 20, clerk—Book-keeping (1st)
Marsh, Alice Mary, 15, telegraph learner—Type-writing (3d)
Marshall, Thomas, 21, clerk—French (1st)
Maxwell, Louis Oswald, 23, clerk—Book-keeping (1st)
Middleton, Tom, 21, clerk—Book-keeping (3d)
Mills, Albert Thomas, 22, clerk—Book-keeping (2d)
Minn, William James, 34, clerk—Book-keeping (2d)
Mitchell, John Arthur, 21, teacher—Book-keeping (2d)
Moore, Mabel, 21, milliner—Book-keeping (3d)
Morgan, Harry Walter, 20, clerk—Book-keeping (2d)
Morton, George Arthur, 15, scholar—Book-keeping (2d)
Mountain, John William, 25, commercial traveller—Book-keeping (3d)
Murray, Joseph, 21, clerk—Spanish (2d)
Napper, Charles Edwin, 26, warehouseman—Book-keeping (2d)
Napper, Henry, 25, clerk—Book-keeping (1st)
Newall, Arthur, 22, clerk—Book-keeping (3d); Shorthand (3d)
Nicklin, William, 13, scholar—Book-keeping (3d)
Nunn, Florence, 23, teacher—German (3d)
Nunn, Gordon, 20, violinist—German (3d)
Nuttall, Leonard, 21, insurance official—Book-keeping (2d)
Oldham, John William, 19, banker's clerk—Book-keeping (2d)
Openshaw, Frank, 15, scholar—Book-keeping (2d)
Osbaldeston, J., 19, clerk—Book-keeping (2d)
Owen, Charles Oldham, 16, scholar—Book-keeping (3d)
Owen, Edwin, 41, correspondent—Portuguese (1st)
Palmer, Annie, 18 (no occupation stated)—Book-keeping (2d)
Parrish, John, 14, scholar—Book-keeping (3d)
Parry, John Thomas, 29, clerk—Book-keeping (1st)
Paulden, Herbert Ashton, 26, clerk—Book-keeping (2d)
Pilkington, Harold Ernest, 19, clerk—Book-keeping (2d)
Pitt, Benjamin, 24, clerk—Book-keeping (2d)
Platt, A. E., 18, shorthand clerk—Book-keeping (2d)
Prax, Kate Gertrude, 23, type-writer—Book-keeping (2d)
Priestman, Robert, 28, clerk—Book-keeping (1st)
Priestman, William Henry, 26, clerk—Book-keeping (2d)
Quick, William Herbert, 20, clerk—German (3d)
Redfern, Samuel, 24, clerk—Book-keeping (1st)
Renshaw, George, 24, clerk—Shorthand (3d)
Richards, George Brinley, 21, clerk—Book-keeping (3d)
Richardson, John, 29, clerk—Book-keeping (3d)
Rigg, Gilbert, 18, student—English (3d): Arithmetic (3d)
Rimington, Louis, 13, scholar—Book-keeping (3d)
Rippon, Fred, 22, clerk—Book-keeping (2d)
Roberts, Albert J., 25, shorthand clerk—Book-keeping (2d)
Robinson, Edward, 23, clerk—Book-keeping (1st)
Robinson, John, 19, shop assistant—Book-keeping (3d)
Robinson, William James, 13, scholar—Book-keeping (2d)
Rogerson, Henry Hall, 14, scholar—Book-keeping (3d)
Rome, Margaret Mitchell, 21 (no occupation)—Type-writing (3d)
Rostron, William, 17, bankers' clerk—Book-keeping (2d)
Sandiford, George Frederick, 29, clerk—Book-keeping (1st)
Sankey, Harold, 14, scholar—Book-keeping (3d)
Sayer, Richard, 21 (no occupation stated)—Book-keeping (1st)
Schwarz, Herbert F., 14, scholar—Book-keeping (2d)
Scotson, Annie, 15, scholar—Book-keeping (3d)
Severs, Arthur Edward, 18, warehouseman—Spanish (2d)

Shaw, William, 19, clerk—Book-keeping (2d)
Sheard, Charles Henry, 22, railway clerk—Spanish (3d)
Shepherd, Arthur Edward, 17, warehouseman—Spanish (3d)
Sibson, Ernest Sheldon, 22, clerk—Book-keeping (2d)
Sibson, John, 21, clerk—Book-keeping (2d); Commercial Geography (3d)
Sidley, Albert, 16, shorthand clerk—Shorthand (2d)
Smith, Adelaide Hindle, 24, governess—English (1st)
Smellie, Albert Edward, 18, correspondent—Book-keeping (3d)
Smith, Joseph Edmund, 22, solicitor's clerk—Spanish (3d)
Smith, Sarah Anne, 35, teacher—Book-keeping (2d)
Smith, Thomas, 13, scholar—Book-keeping (3d)
Sparrow, Ada Elizabeth, 14, student—Book-keeping (3d)
Stark, Florence Maud, 23, clerk—Type-writing (3d)
Stevens, George Eden, 21, toy dealer—Book-keeping (2d)
Stewart, Elizabeth, 16, scholar—Book-keeping (3d)
Stuttard, Ellis, 22, clerk—Book-keeping (1st)
Sutton, Alfred Henry, 30, clerk—French (1st); Spanish (1st)
Swift, John Charles, 24, cloth salesman—Book-keeping (2d)
Taylor, Frederick Herbert, 32, clerk—Book-keeping (1st)
Taylor, Joseph B., 24, clerk—Shorthand (2d)
Taylor, Wilfrid, 15, scholar—Book-keeping (2d)
Taylor, William Ellor, 21, teacher—Arithmetic (3d); Book-keeping (1st)
Telford, Mary Hannah, 16, scholar—Book-keeping (2d)
Thomas, Florence Emily, 18, scholar—English (2d)
Thomas, Percy, 15, scholar—Book-keeping (3d)
Thompson, James, 23, grocer's assistant—Book-keeping (3d)
Tinker, William, 20, clerk—Book-keeping (3d)
Tomlinson, Arthur C., 20, apprentice—Spanish (3d)
Townshend, Robert Ponsonby, 25, engineer—German (2d)
Turner, Edward, 24, clerk—Portuguese (2d)
Turner, Samuel, 22, warehouseman—Book-keeping (2d)
Vaughan, Arthur Frederick, 27, clerk—Book-keeping (1st)
Uhlmann, Alfred, 21, clerk—Spanish (2d)
Wagner, James, 41, cashier—Spanish (2d)
Wainwright, John E., 24, clerk—Shorthand (3d)
Wallwork, Jacob, 22, clerk—Shorhand (2d)
Walton, Denys, 14, scholar—Book-keeping (1st)
Walton, Ernest Allison, 17, clerk—Book-keeping (2d)
Walton, Fred, 26, clerk—Shorthand (1st); Typewriting (3d)
Wardle, Edwin, 18, clerk—Book-keeping (1st)
Wardle, John, 29, clerk—Book-keeping (2d)
Wardley, John, 22, clerk—Book-keeping (2d)
Webb, Annie, 13, scholar—Book-keeping (2d)
Webb, Joseph Charles, 18, clerk—Shorthand (3d)
Whiteside, Herbert, 14, scholar—Book-keeping (3d)
Whittle, Mary Emily, 28, governess—English (1st), the Society's Bronze Medal, and the City Companies' First Prize of £3
Wilkins, William Francis, 21, clerk—Book-keeping (2d)
Wilks, Matthew, 29, clerk—Book-keeping (1st)
Winterton, Martin Leonard, 23, teacher—English (2d)
Wood, George H., 26, salesman—Spanish (2d)
Wood, Thomas, 15, scholar—Book-keeping (3d)
Wood, William, 20, clerk—Book-keeping (2d)
Woodroffe, William Henry, 21, clerk—Book-keeping (1st)
Woodward, Herbert, 20, clerk—Book-keeping (3d)
Woollacott, Edith, 15, scholar—Book-keeping (2d)
Wragg, Herbert James, 23, clerk—Book-keeping (2d)
Wray, Harry, 24, salesman—Book-keeping (1st)
Wrigley, Fred Mitchell, 25, teacher—Book-keeping (2d)
Yates, Jesse, 18, clerk—Book-keeping (1st)
Yates, Thomas, 15, scholar—Book-keeping (3d)
Young, William, 40, schoolmaster—Theory of Music (3d)

MANCHESTER (TECHNICAL SCHOOL).

Allen, John Herbert, 18, warehouseman—Spanish (3d)
Bamber, Harry, 21 (no occupation stated)—German (2d)
Bambroffe, Thomas James, 27, book-keeper—Book-keeping (2d)
Bamford, Thomas, 17, clerk—English (3d); Book-keeping (1st)
Bates, Alfred, 17, clerk—Book-keeping (1st)
Birkby, John Gay, 16, scholar—English (2d)
Bowers, Robert B., 20, clerk—Book-keeping (1st)
Brook, Herbert William, 16 (no occupation stated)—Book-keeping (1st)
Canavan, Peter, 23, clerk—Spanish (2d)
Chadwick, Albert Edward, 21, clerk—Book-keeping (1st)
Chorlton, Frank O. L., 14, scholar—Commercial geography (3d)
Clegg, David, 22, clerk—Italian (1st), and the Clothworkers' Company's Second Prize of £3
Cliffe, Frank Saunders, 15, clerk—Book-keeping (3d)
Cotley, William, 21, clerk—German (1st)
Cowley, Frank, 26, salesman—French (3d)
Crawley, Robert, 18, warehouseman—Book-keeping (2d)

Dawson, C. E., 26, cotton manufacturer's clerk—French (3d)
Deacon, Ernest, 17, accountant's clerk—Book-keeping (3d)
Deacon, Joseph Herbert, 20, salesman—Book-keeping (3d)
Edwards, William, 17, apprentice—Book-keeping (3d)
Ellerby, Jessie, 30, governess—German (1st)
Eyet, Emily, 20, clerk—Book-keeping (1st)
Gee, John Albert, 18, clerk—Book-keeping (1st)
Genger, William, 16, clerk—Book-keeping (1st)
Gittus, Alice, 19 (no occupation stated)—Book-keeping (3d)
Graham, William John, 19, teacher—Book-keeping (3d)
Greenwood, James, 21, clerk—Book keeping (2d)
Hadfield, Annie, 21 (no occupation stated)—French (1st); Italian (1st)
Hadfield, Reginald, 27, cotton mill manager—Shorthand (2d)
Hall, John, 28, cashier—Book-keeping (1st)
Hall, Mary, 27 (no occupation stated)—Italian (2d)
Herbert, Stephen William, 18, clerk—English (2d)
Heywood, Edgar, 21, clerk—Book-keeping (3d)
Heywood, John, 23, clerk—Book-keeping (2d)
Horrocks, John Wesley, 14, shorthand clerk—Shorthand (1st)
Hyde, Harry Seddon, 18, clerk—Book-keeping (2d)
Kay, William Henry, 27, clerk—Book-keeping (3d)
Kelly, John, 23, warehouseman—Spanish (3d)
Kennedy, Lillie, 22, clerk—Book-keeping (2d)
Lamb, Harry, 18, clerk—Book-keeping (3d)
Lamb, Samuel Robert, 27, clerk—Book-keeping (1st)
Landstein, Joseph, 15, student—German (3d)
Lockhart, Ethel Ruth, 19 (no occupation stated)—Shorthand (3d)
Logan, Thomas Graham, 30, merchant's clerk—Spanish (3d)
Lomax, James Wain, 15 (no occupation stated)—English (3d)
McKinnon, Ernest Cyril, 16, scholar—German (3d)
M'Quade, Ada, 24 (no occupation)—Italian (1st), the Society's Bronze Medal, and the Clothworkers' Company's First Prize of £5
Maden, Dionysius, 30, manager—Book-keeping (2d)
Marsh, Frederick Arnold, 18, clerk—Book-keeping (2d)
Nall, Jane, 24, telegraphist—Book-keeping (2d)
Oppenheimer, Albert, 18, mosaist—Book-keeping (3d)
Redfern, Elizabeth, 37 (no occupation stated)—Book-keeping (3d)
Rhind, Thomas William, 19, clerk—Book-keeping (1st)
Rhodes, Campbell Ward, 18, clerk—Shorthand (3d)
Richardson, George, 19, clerk—German (2d)
Roberts, John Henry, 21, clerk—Book-keeping (3d)
Roberts, William Arthur, 17, clerk—Book-keeping (2d)
Robertson, Robert Francis, 31, book-keeper—German (1st)
Robinson, Helen, 18 (no occupation)—German (1st)
Royle, Aaron, 32, clerk—Book-keeping (1st)
Sandom, William, 21, clerk—Book-keeping (2d)
Sharples, Ernest, 16, clerk—Book-keeping (1st)
Sharples, Harry, 21, clerk—Book-keeping (1st)
Shepley, William Atkinson, 17, apprentice—Book-keeping (2d)
Smith, Leonard, 21, clerk—Book-keeping (2d)
Statham, Reginald, 19, clerk—Book-keeping (3d)
Taylor, Thomas Edward, 22, clerk—French (3d); German (3d)
Taylor, William, 19, salesman—Book-keeping (3d)
Titley, Thomas Minta, 22, cashier—Book-keeping (1st)
Tudor, Edward Henry, 20, clerk—Book-keeping (2d)
Varley, Henry Allen, 19, warehouseman—French (1st)
Walton, Barron, 25, warehouseman—Spanish (2d)
Wilkinson, Henry, 21, warehouseman—Book-keeping (2d)
Williams, Jas., 19, correspondent—Shorthand (1st)
Williams, John, 20, clerk—Book-keeping (1st)
Willington, Mary, 26, machinist—Book-keeping (3d)
Wilson, Annie, 24, telegraphist—Book-keeping (3d)

MARKET HARBOROUGH (GRAMMAR SCHOOL).

Davies, John Nicholls, 14, scholar—Commercial Geography (2d)
Elliott, James Goodman, 15, scholar—Commercial Geography (2d)
Healey, Percy Everett, 13, scholar—Commercial Geography (2d)
Joule, Charles Frederick, 15, scholar—Commercial Geography (3d)
Miller, Frank William, 15, scholar—Commercial Geography (3d)
Tebbutt, Alfred, 15, pupil—Commercial Geography (2d)
Tompkins, Charles Edgar, 16, scholar—Commercial Geography (3d)

MIDDLESBROUGH (GRAMMAR SCHOOL).

Alderson, William, 13, student—Book-keeping (3d)
Archibald, John, 14, student—Book-keeping (2d)
Cook, William, 20, clerk—Book-keeping (3d)
Dent, Fred, 15, student—Book-keeping (3d)

Forbes, Ernest Edward, 13, student—Book-keeping (3d)
Horseman, Henry John, 25, clerk—Book-keeping (1st)
Latham, Lawrence Edwin, 16, clerk—Book-keeping (3d)
Matthews, Hedley Franklin, 14, student—Book-keeping (2d)
Scott, Fred, 14, student—Book-keeping (3d)
Shaw, Walter Armstrong, 15, student—Book-keeping (3d)
Smollan, Jacob, 13, student—Book-keeping (3d)
Smith, Lionel, 18, clerk—Book-keeping (3d)

NEWCASTLE-ON-TYNE (SCIENCE AND ART SCHOOLS.)

Bell, Ernest Anderson, 17, clerk—Shorthand (3d); German (3d)
Cooke, Mary, 24, teacher—German (3d)
Cross, William, 21, clerk—German (2d)
Dawe, George Henry Trannack, 17 (no occupation stated)—Book-keeping (3d)
Dickinson, Edward Scott, 19, clerk—Book-keeping (3d)
Dixon, William Coulson, 20, clerk—Spanish (2d); Portuguese (2d)
Harrison, James Henry, 21, clerk—German (2d)
Hudson, Everett Lawson, 19, clerk—Book-keeping (2d)
Keogh, Andrew, 22, librarian—German (3d)
Nelson, Emily, 15, scholar—German (3d)
Thompson, John Thomas, 17, clerk—Type-writing (2d)
Turnbull, Thomas, 19, clerk—Book-keeping (2d)
Vernon, Gertrude, 18, shop-assistant—German (3d)
Watson, Frederick Yarrow, 28, clerk—Book-keeping (2d)
Wilson, Andrew William, 24, cashier—German (1st)

NEW CROSS (GOLDSMITHS' COMPANY'S INSTITUTE).

Adam, Amy Blanche, 21 (no occupation stated)—Theory of Music (3d)
Aldous, Frederick, 19, clerk—Book-keeping (2d)
Andrews, Arthur, 25, clerk—Book-keeping (2d)
Angel, Samuel F., 28, clerk—Book-keeping (2d)
Axford, Albert, 19, clerk—Theory of Music (3d)
Barker, James William, 44, ropemaker—Theory of Music (3d)
Barnett, Harriet, 22, teacher—French (3d)
Barnett, William, 27, teacher—French (3d)
Barry, Laura Kate, 19, pupil teacher—English (3d)
Bevan, Albert Edward, 18, clerk—Book-keeping (2d)
Brown, Harry, 23, clerk—Book-keeping (3d)
Culver, Lizzie, 28, teacher—Book-keeping (2d)
Davies, Albert, 16, clerk—Shorthand (3d)
Day, Louisa D., 23 (no occupation stated)—Theory of Music (3d)
Day, Walter, 20, clerk—Book-keeping (1st)
Dickson, Alexander, 23, accountant's assistant—Book-keeping (2d)
Edwards, Clement Martin, 21, clerk—Book-keeping (2d)
Fry, Thomas Hallett, 18, clerk—Theory of Music (2d)
Gaymer, Catherine Betsy, 28, schoolmistress—Book-keeping (3d)
Gaymer, John Thomas, 32, schoolmaster—Book-keeping (3d)
Griffiths, William, 46, teacher—Book-keeping (3d)
Gcatley, Jennie Elizabeth, 22, teacher—Theory of Music (3d)
Gloag, Lucy Agnes, 20 (no occupation stated)—Book-keeping (3d)
Goldsmith, William, 21, clerk—Book-keeping (2d)
Granger, Ernest, 30, clerk—Book-keeping (3d)
Hickling, Eliza, 22, governess—Theory of Music (3d)
Kennedy, Arthur, 27, clerk—Theory of Music (3d)
Lambie, William Henry, 17, clerk—Book-keeping (2d)
Mason, Frederick George, 24, clerk—Book-keeping (1st)
Mather, Joseph Tatton, 42, cashier—Book-keeping (3d)
Meagor, Winifred Edith, 22 (no occupation stated)—Theory of Music (3d)
Mitchell, John, 31, schoolmaster—Book-keeping (1st)
Moir, William, 37, clerk—Book-keeping (1st)
Monshall, Alfred John, 27, secretary to a public company—Book-keeping (1st)
Nelson, Joseph, 36, clerk—Book-keeping (1st)
Nobbs, Arthur, 34, schoolmaster—Book-keeping (1st)
Parsons, Rosa C., 26, clerk—Theory of Music (2d)
Plumstead, Percy, 16, clerk—Arithmetic (3d)
Pohl, Eliza, 31, teacher—Theory of Music (3d)
Reeve, George, 15, office-boy—Shorthand (2d)
Robinson, Mary, 25 (no occupation stated)—Book-keeping (3d)
Saunders, Margaret, 23, governess—Theory of Music (3d)
Shinn, Alfred, 29, teacher—Book-keeping (2d)
Slater, Charles Herbert, 20, clerk—Shorthand (3d)
Smith, Edith, 24 (no occupation stated)—Book-keeping (3d)
Snape, William Laurie, 20 (no occupation stated)—Book-keeping (3d)
Speedie, George James, 21, clerk—Book-keeping (2d); Shorthand (3d)
Swan, Ida Marian, 15 (no occupation stated)—Theory of Music (3d)
Watkins, Herbert, 16, apprentice—Book-keeping (2d)
Watts, Gertrude Sarah, 18 (no occupation stated)—Theory of Music (3d)
Whibley, Lillie, 25, teacher—Theory of Music (2d)
Windebank, Robert, 30, teacher—Book-keeping (2d)
Wood, Charles Burgess, 20, clerk—Book-keeping (1st)

Woolmer, Alfred Henry, 23, clerk—Book-keeping (3d)
Wren, William Henry, 25, clerk—Shorthand (3d)
Wright, Blanche, 32 (no occupation stated)—Book-keeping (2d)
Wright, John, 24, clerk—Book-keeping (2d)
Wyatt, Alfred James, 20, clerk—Book-keeping (2d)

NEWTON HEATH.

De Looze, John, 19, clerk—Book-keeping (2d)
Evans, William Barlow, 19, apprentice—Book-keeping (3d)
Garlick, Tom, 22, gas-meter inspector—Book-keeping (3d)
Hopwood, John Edwin, 17, warehouseman—Book-keeping (3d)
Hopwood, Walter, 19, warehouseman—Book-keeping (2d)
Horrocks, Thomas, 18, clerk—Book-keeping (2d)
Hull, Isaac, 17, clerk—Book-keeping (2d)
Jackson, George Richard, 22, clerk—Book-keeping (3d)
Passmore, George Wm., 19, warehouseman—Book-keeping (2d)
Whitehead, Fred, 19, warehouseman—Book-keeping (2d)

NORWICH.

Hamilton, Rev. John Miller, 37, Baptist minister—English (3d); Domestic Economy (2d)
Rodwell, Henry, 37, reader—English (2d)

NOTTINGHAM (UNIVERSITY COLLEGE).

Biddle, Edward, 21, surveyor—German (2d); Italian (2d); French (2d)
Braddock, Joseph Henry, 24, clerk—Book-keeping (2d)
Buxton, John, 21, clerk—Book-keeping (2d)
Buxton, William, 24, clerk—Book-keeping (2d)
Chadbourne, Edith Mary, 27 (no occupation stated)—Spanish (2d)
Cross, Arthur Cecil, 19, clerk—Book-keeping (3d)
Greendale, Samuel Edwin, 22, clerk—Shorthand (2d)
Humphris, John Alexander, 28, teacher—Domestic Economy (2d)
Mills, Frederick Fletcher, 24, clerk—Book-keeping (3d)
Swift, John Arthur, 39, teacher—Spanish (2d); German (1st); French (1st)
Wilkinson, William, 21, clerk—Book-keeping (3d)
Wood, Joseph Turney, 26, leather dresser—Spanish (3d)

OLDHAM (INDUSTRIAL CO-OPERATIVE SOCIETY).

Andrew, Oswald, 20, clerk—Book-keeping (1st)
Bright, Arthur, 20, clerk—Book-keeping (2d)
Buckley, Mark, 18, warehousman—Book-keeping (3d)
Dean, Edward, 22, clerk, Book-keeping (3d)
Evans, Edward, 23, warehouseman—Book-keeping (2d)
Fernley, Herbert, 20, clerk—Book-keeping (1st)
Garlick, John Henry, 23, warehouseman—Book-keeping (2d)
Goddard, John, 23, clerk—Book-keeping (1st)
Jackson, Charley, 21, warehouseman—Book-keeping (1st)
Johnson, Herbert, clerk—Book-keeping (2d)
Lawton, Arthur, 18, clerk—Book-keeping (2d)
Meadowcroft, Joseph, 24, clerk—Book-keeping (3d)
Priestner, George E. S., 22, clerk—Book-keeping (2d)
Rodgers, Joseph, 18, apprentice—Book-keeping (2d)
Scholes, Thomas, 27, warehouseman—Book-keeping (1st)
Taylor, James, 17, packer—Book-keeping (2d)
Thomas, Albert, 28, clerk—Book-keeping (2d)

PENZANCE (MINING AND SCIENCE SCHOOL, AND SCHOOL OF ART).

Allen, Mary, 50, teacher—French (2d)
Becherleg, Ida, 11, scholar—Theory of Music (3d)
Culyer, Elizabeth M., 40, teacher—French (2d)
Edmonds, Alice Mary, 11, scholar—Theory of Music (3d)
Manning, Florence Mary, 13, scholar—Theory of Music (3d)
Noy, Wilmot C., 24, teacher—Theory of Music (3d)
Tregoning, Ellen, C. 12, scholar—Theory of Music (3d)
White, Harriet Annie, 36, teacher—Theory of Music (1st)

PLYMOUTH (PUBLIC SCHOOL).

Butcher, Jane, 15, teacher—Theory of Music (3d); Domestic Economy (2d)
Capps, Mabel Alice, 18, teacher—Theory of Music (2d)
Carter, Kate Mary, 13, scholar—Domestic Economy (3d)
Clemow, Minnie Helena, 15, scholar—Domestic Economy (3d)
Dight, William Henry, 17, teacher—Commercial Geography (3d)
Doidge, Ethel Sarah, 13, scholar—Theory of Music (3d)
Foster, Francis William, 21, teacher—Commercial Geography (3d)
Granger, Sarah, 13, scholar—Domestic Economy (3d)
Horrell, Blanche, 18, teacher—Domestic Economy (2d)
Hughes, Thomas Edward, 21, teacher—English (1st)

Isaac, Minnie, 18, teacher—Theory of Music (3d)
Jinkin, Minnie C., 12, scholar — Domestic Economy (3d)
Key, John, 20, clerk—Arithmetic (3d); Book-keeping (2d)
Lethbridge, Ethel, 12, scholar — Domestic Economy (3d)
Lucas, James Henry, 23, teacher—Theory of Music (1st); Arithmetic (2d)
Minhinnett, Nelly, 16, scholar—Theory of Music (3d)
Monk, Alice Louisa, 20, pupil-teacher — Domestic Economy (2d); Theory of Music (3d)
Monk, Beatrice H., 17, pupil-teacher—Theory of Music (3d)
Partington, Charles, 17, teacher—Commercial Geography (3d)
Pleace, Beatrice Lang, 19, pupil-teacher—Theory of Music (3d); Domestic Economy (2d)
Pleace, Emily Jane, 17, scholar—Domestic Economy (3d)
Porteus, George, 29, teacher—Theory of Music (3d)
Raffell, Albion, 18, teacher — Commercial Geography (3d)
Rowe, Katie Gertrude, 15, pupil-teacher—Theory of Music (3d)
Saunders, Florence, 14, scholar—Domestic Economy (3d)
Vanstone, Benjamin Thomas, 29, schoolmaster—Theory of Music (3d)
Waddy, Reginald John Lawrence, 14, scholar—Theory of Music (2d)
Walke, Nellie, 13, scholar—Domestic Economy (3d)
Warren, Elizabeth, 14, scholar — Domestic Economy (3d)

PLYMOUTH (SCHOOL OF SHORTHAND).

Barlow, Robert, 19, clerk—Shorthand (3d)
Body, Alfred Charles, 28, clerk—Shorthand (2d)
Clark, Amy Rose, 16, student—Shorthand (3d); Typewriting (3d)
Floyd, Alfred Edward, 23, type-writer—Typewriting (3d); Shorthand (1st)
Garland, Thonas, 22, clerk—Shorthand (3d)
King, Joseph Charles, 23, clerk—Shorthand (3d)
Leddra, Robert, 21, clerk—Shorthand (3d)
Loveland, Arthur, 17, clerk — Shorthand (3d)
Pinkham, John Waymouth, 18, accountant—Shorthand (2d)
Richards, Ernest James, 20, clerk—Typewriting (3d); Shorthand (3d)
Searle, John Thomas, 21, clerk—Shorthand (3d)
Shade, Jessie, 21, clerk—Type-writing (3d)
Syms, Albert George Ernest, 18, clerk—Shorthand (3d)
Wherly, William Henry, 18, clerk—Shorthand (3d)
York, Alfred George, 15, clerk—Shorthand (3d)

PRESTON (HARRIS INSTITUTE).

Adamson, Elizabeth, 23, dressmaker—English (3d)
Ayres, Robert, 18, pupil-teacher—Arithmetic (3d)
Ayres, Thomas, 14, pupil-teacher—Arithmetic (3d)
Backhouse, Seth, 29, overlooker—Theory of Music (3d)
Bee, Henry Parker, 13, scholar—Book-keeping (2d)
Beesley, Henry Saul, 15, scholar—Book-keeping (3d)
Bennett, John Francis, 20, clerk—Shorthand (3d)
Berry, Eliza Mary Alice, 17 (no occupation stated)—Theory of Music (3d)
Bolton, John Kay, 14, scholar—Book-keeping (2d)
Bostock, Herbert, 12, scholar—Book-keeping (2d)
Bowie, William, 14, scholar—Book-keeping (2d)
Busher, Edwin, 20, clerk — Book-keeping (3d)
Cowell, Fred, 16, clerk—Shorthand (3d)
Croasdale, John Herbert, 20, clerk—English (3d)
Cunningham, Andrew, 18, printer—Theory of Music (3d)
Dobson, Robert, 25, labourer—Theory of Music (3d)
Easterby, Robert Fisher, 18, clerk—Book-keeping (2d)
Eastham, Thomas, 16, scholar—English (3d)
Edge, Herbert, 14, scholar—Book-keeping (2d
Fallowfield, John Ernest, 19, assistant-master—English (2d)
Fazackerley, Arthur, 14, scholar—Book-keeping (3d)
Fish, Edith Mary, 21, no occupation stated—Theory of Music (3d)
Forshaw, Ellen, 19 (no occupation)—Theory of Music (3d)
Fox, Isabella, 19, pupil teacher—English (3d)
Gardner, Charles Frederick, 19, clerk—Book-keeping (1st); Shorthand (2d); Typewriting (3d)
Garner, John B. 28, cashier—Book-keeping (1st)
Green, Aaron, 19, mill warehouseman—Arithmetic (3d)
Greenwood, Henry James, 16, clerk—Book-keeping (2d)
Hague, James Frederick, 14, scholar—Book-keeping (3d)
Harrison, Edward, 13, student—Book-keeping (2d)
Hesketh, Fred, 20, weaver—Theory of Music (3d)
Higginson, Arnold, 12, clerk — Shorthand (3d)
Holland, James Mercer, 15, apprentice—Shorthand (3d)
Hulme, Thomas, 21, assistant relieving officer—Book-keeping (2d)
Ireland, Ignatius, 17, student—English (3d)
Lamb, George, 18, watchmaker—Book-keeping (2d)

Lang, George, 16, warehouse boy—Theory of Music (2d)
Lang, Thomas, 19, clerk — Shorthand (3d); Book-keeping (1st)
Leech, Frederick Sydney, 17, clerk—Theory of Music (3d)
Lynex, William Thurstan, 14, scholar—Book-keeping (3d)
Macaw, Warren Kennedy, 14, scholar—Book-keeping (2d)
Marsden, Agnes Hannah, 17 (no occupation stated)—Theory of Music (3d)
Mayor, Peter, 18, clerk—Shorthand (3d)
Merigold, Walter E., 17, apprentice—Theory of Music (3d)
Miller, Thomas Edward, 23, assistant schoolmaster—Shorthand (2d)
Moss, Richard, 26, assistant schoolmaster—Book-keeping (3d); Shorthand (3d)
Napthen, Annie, 20 (no occupation stated)—Book-keeping (2d)
Napthen, Mary Cozbi, 22, teacher—English (2d)
Napthen, Samuel, 17, clerk—Shorthand (2d)
Parker, George, 20, clerk—Shorthand (2d); English (3d)
Rawcliffe, Frederic Arthur, 19, clerk—Arithmetic (3d); Shorthand (3d)
Rawlinson, George Ernest, 17, clerk—Shorthand (2d)
Richmond, William, 19, bootmaker—Theory of Music (3d)
Riding, Henry, 17, warehouse boy—Theory of Music (2d)
Rigby, William, 16, scholar—Book-keeping (3d)
Roberts, Thomas Davies, 23, clerk—Book-keeping (2d)
Robinson, Alfred, 21, clerk—Type-writing (2d)
Roe, William Hamilton, 14, scholar—Book-keeping (3d)
Roscoe, Frederick Charles, 15, scholar—Book-keeping (2d)
Roscoe, Joseph Edward, 13, scholar—Book-keeping (3d)
Rose, Edward, 26, cloth looker—Arithmetic (3d)
Saul, Robert, 19, gardener—Book-keeping (2d)
Slater, Thomas, 31, tape sizer—Theory of Music (2d)
Smith, Joseph, 18, clerk—Shorthand (3d)
Swift, Frederick, 16, warehouseman—Theory of Music (2d)
Tansley, Harold Glendower, 15, scholar—Book-keeping (2d)
Taylor, Edward Ashworth, 14, student—Book-keeping (2d)
Taylor, Joseph Lees, 13, scholar — Book-keeping (2d)
Taylor, Leonard Gibson, 14, student—Book-keeping (3d)
Taylor, Miriam, 19, student—Theory of Music (3d)
Tomlinson, David, 16, clerk—Shorthand (3d)
Topping, James, 24, assistant schoolmaster—Arithmetic (1st), and the Society's Bronze Medal
Toulmin, George Fisher, 14, scholar—Book-keeping (2d)
Toulmin, John, 16, clerk—Book-keeping (3d)
Townley, James, 16, clerk—Theory of Music (2d); Shorthand (2d)
Turner, John Taylor, 15, scholar — Book-keeping (3d)
Westworth, Arthur, 21, clerk—Type-writing (3d)
Whittle, John, 21, book-keeper—Book-keeping (1st)
Willmoth, Walter John, 15, clerk—Book-keeping (2d); Shorthand (3d)
Wood, Charles Robert, 19, clerk — Book-keeping (2d)

READING.

Farley, Lewis, 26, clerk—Shorthand (3d)
Lambdin, William James, 17, clerk—Shorthand (3d)
Love, Ernest George, 18, clerk—Shorthand (3d)

ROCHDALE (ENGINEERING SCHOOL).

Brierley, Albert, 21, clerk—Book-keeping (2d)
Graham, Thomas, 25, clerk—Book-keeping (2d)
Holden, Benjamin, 18, assistant—Book-keeping (1st)
Lineham, Samuel, 18, clerk—Book-keeping (2d)
Lord, William, 32, clerk—Book-keeping (2d)
Robinson, Jesse, 22, clerk—Book-keeping (2d)
Sutcliffe, Oscar, 23, clerk—Book-keeping (1st)
Taylor, James Edmund, 19, clerk — Book-keeping (2d)

SALFORD (SCHOOL BOARD).

Baghurst, Charles William, 22, teacher — Book-keeping (3d)
Clare, Ernest, 20, clerk—Book-keeping (3d)
Cooper, Albert, 19, clerk—Book-keeping (3d)
Gregg, Harry, 17, office-boy—Book-keeping (2d)
Johnson, Harry W., 16, clerk—Book-keeping (2d)
Jones, Arthur Cartledge, 24, time-keeper—Book-keeping (2d)
Jones, John Owen, 15, scholar—Book-keeping (3d)
Martin, James Parker, 19, clerk—Book-keeping (2d)
Mills, Charles Manchester, 20, clerk—Book-keeping (2d)
Partington, Joseph, 35, clerk—Book-keeping (2d)
Roberts, Osborne, 17, clerk—Book-keeping (2d)
Spary, David, 47, clerk—Book-keeping (3d)
Stringer, James Robert, 20, clerk—Book-keeping (2d)
Todd, John L., 18, clerk—Book-keeping (2d)

SHEFFIELD (YOUNG MEN'S CHRISTIAN ASSOCIATION).

Chambers, William Henry, 24, clerk—French (3d); German (3d)

Clements, Robert Gilbert, 17, clerk—Spanish (3d)
Cook, Arthur, 26, clerk—Spanish (3d)
Fearn, Willie, 15 (no occupation stated)—Spanish (3d)
Glossop, Ernest, 25, clerk—French (3d)
Linacre, Hugh William John, 18, clerk—German (3d)
Thompson, Henry, 26, clerk—Spanish (3d)
Woodley, George Tom Burr, 26, clerk—Shorthand (2d)

SOUTHAMPTON (ALEXANDRA COLLEGE, SHIRLEY).

Ashford, Ella Mabel, 16, pupil—Domestic Economy (1st)
Ashford, Lilian Mai, 14, pupil—Domestic Economy (1st)
Bacon, Edith, 15, student—Domestic Economy (3d)
Barter, Rose Dora, 13, pupil — Domestic Economy (3d)
Durston, Gertrude Alice, 13, pupil—Domestic Economy (2d)
Durston, Mabel Louise, 11, pupil—Domestic Economy (3d)
Elliott, Edith Alice, 15, pupil—Domestic Economy (1st)
Gawler, Mary Hannah Marina, 15, pupil—Domestic Economy (3d)
Gray, Hilda Evelyn, 12, pupil—Domestic Economy (2d)
Hill, Evelyn Elizabeth, 14, pupil—Domestic Economy (3d)
Houghton, Lilian Elizabeth, 13, student—Domestic Economy (2d)
Johnson, Alice Muriel, 16, pupil—Domestic Economy (2d)
Lunn, Ellen Mabel, 14, pupil — Domestic Economy (2d)
McCulloch, Lucie, 16, pupil—Domestic Economy (1st), and the Society's Bronze Medal
McCulloch, Mary, 14, pupil—Domestic Economy (2d)
Morris, Ethel Mary, 16, pupil — Domestic Economy (2d)
Morton, Gwendoline Skyrme, 12, pupil — Domestic Economy (3d)
Norman, Beatrice Amelia, 14, pupil—Domestic Economy (2d)
Read, Minnie Elizabeth, 15, pupil—Domestic Economy (2d)
Smith, Constance Evelina, 16, pupil—Domestic Economy (2d)
Wintle, Katherine, 14, pupil — Domestic Economy (2d)
Wintle, Mary Holder, 16, pupil—Domestic Economy (2d)
Wood, Ethel Lilian, 16, pupil — Domestic Economy (1st)
Wood, Juanita Ysabella, 14, pupil—Domestic Economy (2d)

SOUTHAMPTON (HARTLEY INSTITUTION).

Belcher, Caroline, 24, governess—French (3d)
Branford, William, 25, chemist's assistant—French (3d)
Broomfield, Walter, 19, clerk—Book-keeping (3d)
Carroll, John Henry, 16, student—German (3d)
Cavers, Juan, 37, Customs' officer—Spanish (2d)
Clark, James Frederick, 34, organist—Theory of Music (2d)
Corben, Ebenezer, 37, messenger—German (1st)
Guidel, Maria, 24, teacher—French (2d)
Hamilton, Gertrude Hamilton, 16 (no occupation)—Book-keeping (3d)
Jeffery, Alice Maude, 26 (no occupation)—German (1st)
Locke, Charles Henry, 20, clerk—Book-keeping (3d)
McDade, Francis, 35, teacher—French (2d)
Pirouet, Ezit Annie, 18, teacher—German (3d)

SPENNYMOOR.

Haddock, John Frederic, 27, book-keeper—Book-keeping (1st)
Pickering, Joseph, 24, clerk—Book-keeping (1st)
Pickering, Matthew, 21, clerk—Book-keeping (2d)

STALYBRIDGE (MECHANICS INSTITUTION).

Bentley, Frank, 18, clerk—Book-keeping (2d)
Booth, Samuel, 19, storekeeper—Book-keeping (2d); Shorthand (1st)
Boyes, John Frederick, 24, cloth looker—Book-keeping (3d)
Buckley, John, 23, teacher—Book-keeping (2d)
Cooke, Robert, 25, clerk—Book-keeping (1st)
Dawson, Harry, 19, cotton operative—Shorthand (3d)
Dunlop, James Samuel, 15, clerk—Book-keeping (2d)
Durham, Charles Henry, 25, timekeeper—Book-keeping (1st)
Gudger, John Lees, 26, clerk—Book-keeping (2d)
Hall, Harry, 16, clerk—Book-keeping (2d)
Kirkham, Alfred, 31, clerk—Book-keeping (3d)
Lees, Charles, 18, clerk—Book-keeping (3d)
Lockwood, Joseph, 19, weaver—Book-keeping (3d)
Marsden, Walter, 26, clerk—Book-keeping (1st)
Middleton, Harry, 17, apprentice — Book-keeping (2d)
Needham, David, 27, cotton weaver—Book-keeping (3d)
Newton, John, 18, clerk—Book-keeping (3d)
Ramsden, John, 17, clerk—Book-keeping (2d)
Roebuck, George Henry, 29, clerk—Book-keeping (2d)
Schooler, John, 17, clerk—Shorthand (2d); Book-keeping (2d)
Smith, Edward Kerfoot, 22, clerk—Book-keeping (3d)
Stafford, Thomas, 16, clerk—Book-keeping (2d); Shorthand (3d)

Taylor, Edward, 21, cotton spinner's piecer—Book-keeping (2d)
Teare, John Henry, 20, clerk—Book-keeping (3d)
Worsley, John, 17, clerk—Book-keeping (3d)

STEVENAGE GRAMMAR SCHOOL.

Ashby, William Henry, 13, scholar—Book-keeping (3d)
Beeson, Richard William Geo., 14, scholar—Book-keeping, (3d)
Gazely, John Harold, 13, scholar—Book-keeping (3d)
Gow, Norman, 13, scholar—Book-keeping (3d)
Harper, Philip, 14, scholar—Book-keeping (3d)
Shelford, Albert John, 15, scholar—Book-keeping (3d)
Wurr, Percy Nicholson, 12, scholar—Book-keeping (2d)

STOCKPORT (TECHNICAL SCHOOL).

Bailey, Harry, 22, clerk—Shorthand (3d)
Brown, James Edward, 14, scholar—English (3d)
Etchells, William, 14, student—English (3d)
Wallwork, Robert Knowles, 19, clerk—Shorthand (3d)

STOCKTON-ON-TEES (YOUNG MENS CHRISTIAN ASSOCIATION).

Gough, Frank Edward, 20, clerk—Book-keeping (2d)

SUNDERLAND (YOUNG MEN'S CHRISTIAN ASSOCIATION).

Allan, Robert J. C., 23, clerk—Book-keeping (1st)
Burkett, Richard Southern, 19, clerk—Book-keeping (2d)
Dawson, Tom, 31, book-keeper—Book-keeping (1st)
Hinde, Joseph William, 26, clerk—Book-keeping (1st)
Jennings, Cornelius, 28, clerk—Book-keeping (2d)
Mason, George Alexander, 17, clerk—Book-keeping (3d)
Rivett, Charles, 23, apprentice—Book-keeping (3d)
Shepherd, Amy Beatrice, 19, governess—German (3d)

SWINDON.

Brown, Albert William, 21, clerk—Book-keeping (2d)
Byett, Henry, 22, clerk—Book-keeping (3d)
Franklin, Harry, 19, clerk—Book-keeping (1st); Shorthand (2d)
Jones, Wilfred Lawson, 20, clerk—Book-keeping (3d)
King, George, 18, clerk—Shorthand (3d); Book-keeping (2d)
Matthews, Septimus Nullis, 19, clerk—Book-keeping (3d)
Payne, Charles Allan, 16, clerk—Book-keeping (3d)
Schmitz, John, 20, watch-repairer—Book-keeping (3d)
Stock, William, 18, clerk—Book-keeping (2d)
Wall, George Frank, 21, grocer's assistant—Book-keeping (3d)
White, Arthur Jeffreys Lewis, 19, clerk—Shorthand (3d); Book-keeping (3d)
Willis, Albert Arthur, 17, clerk—Shorthand (3d)

WALSALL (SCIENCE AND ART INSTITUTE).

Allen, Joseph, 23, miner—Theory of Music (3d)
Allen, Samuel, 21, auger filer—Theory of Music (2d)
Allsopp, Polly, 19 (no occupation)—Theory of Music (3d)
Bayliss, Charles William, 23, merchant's clerk—Spanish (3d)
Beard, Edward Vincent, 17, commercial clerk—Theory of Music (3d)
Bird, Albert Edward, 22, clerk—Book-keeping (2d)
Boonham, Annie, 19, schoolmistress—Domestic Economy (2d)
Boot, Henry, 27, auger filer—Theory of Music (2d)
Callear, Samuel B., 37, baker—Theory of Music (1st)
Camwell, Mary Jane, 43, housekeeper—Domestic Economy (2d)
Carver, John David, 16, bridle cutter—Spanish (3d)
Chavasse, Isabella Mary, 18, shorthand clerk and type-writer—Shorthand (3d)
Christie, George Watt, 22, saddler—Theory of Music (2d)
Clarke, William Edward, 19, warehouseman—Theory of Music (3d)
Dance, John William, 17, apprentice—Spanish (3d)
Donnelly, Rose, 17, harness stitcher—Theory of Music (3d)
Evans, Robert, 19, clerk—Book-keeping (3d)
Firkin, Joseph, 18, teacher—Domestic Economy (2d)
Hall, Caroline E., 22, teacher—Theory of Music (1st)
Hall, Ellen Lavinia, 27 (no occupation stated)—Theory of Music (3d)
Harrison, Walter George, 22, clerk—German (3d); Shorthand (2d)
Hollins, William Bertie, 18, organ builder—Theory of Music (3d)
Lowe, Thomas Edward Griffiths, 25, tube maker—Theory of Music (3d)
Maddocks, John Robert Dawson, 25, tailor's cutter—Domestic Economy (3d)
Mills, Henry George, 20, clerk—Book-keeping (3d)
Odgers, Edward, 22, brass-finisher—Theory of Music (3d)
Ray, Dinah, 26, schoolmistress—Theory of Music (3d)
Thickett, Thomas, 21, clerk—Shorthand (3d)

Walker, Herbert Theodore, 15, pupil-teacher—Theory of Music (3d)
Williams, George Ernest, 21, tailors' cutter—Domestic Economy (2d)
Wood, Florence Ada, 18 (no occupation stated)—Theory of Music (3d)
Woodcock, Charlotte, 36, schoolmistress—Book-keeping (3d)

WARRINGTON (TECHNICAL INSTITUTE).

Bunch, Henry, 30, clerk—German (2d)
Brookes, John Alexander, 26, book-keeper—German (3d)
Sherwood, Arthur James, 17, clerk—German (1st)

WATFORD (PUBLIC LIBRARY).

Course, George Frederick, 18, clerk—Book-keeping (2d)
Haywood, George Hopkinson, 21, clerk—Book-keeping (1st)
Haywood, Horace, 19, library assistant—Shorthand (1st)
Pratt, James Alfred, 24, clerk—Book-keeping (2d)
Seymour, Alfred Bliss, 23, secretary—Shorthand (1st)

WIMBLEDON INSTITUTE.

Pascall, Flora, 20, clerk—Book-keeping (3d)
Whiting, Frederic, 14, clerk—Book-keeping (3d)

WOLVERHAMPTON (FREE LIBRARY).

Baillie, Janie, 18 (no occupation stated)—Theory of Music (3d)
Bennett, A. J., 19, rate collector—Shorthand (3d)
Blenkin, Thomas Henry, 21, stationer's assistant—Theory of Music (3d)
Bowers, Alfred Sidney, 20, clerk—Shorthand (3d)
Cliff, Frederick George, 24, clerk—Shorthand (3d)
Darby, George Ernest, 18, stationer's assistant—Theory of Music (2d)
Duggan, Herbert John, 19, clerk—Spanish (3d)
Gill, Joseph Oliver, 21, clerk—French (3d); Spanish (2d); German (3d)
Handley, Lillie, 22 (no occupation)—Theory of Music (3d)
Lawton, Harry, 31, clerk—Type-writing (3d)
Love, Charles Edward, 19, organ builder—Theory of Music (2d)
Mitchell, Emily, 28, nurse—English (3d)
Onions, William, 20, clerk—Spanish (3d)
Ostler, Herbert Henry Collins, 24, clerk—Spanish (3d)
Parsons, Harry J., 21, clerk—Spanish (3d)
Pickering, Thomas Farmer, 19, book-binder—Theory of Music (3d)
Ravenscroft, Wallace William, 24, book-keeper—Spanish (3d)
Rew, Harry, 19, shop assistant—Theory of Music (3d)
Robbins, Edith Louisa, 18 (no occupation)—Theory of Music (3d)
Ruston, Clara Elizabeth, 26, teacher—Domestic Economy (1st), and the Society's Bronze Medal
Smith, Alfred Valentine, 22, clerk—Spanish (3d)
Steward, Minnie, 26 (no occupation)—Domestic Economy (2d)
Weaver, Jane, 26 (no occupation)—Domestic Economy (2d)
Whitehead, Fanny H., 24, cashier and clerk—English (3d)

WOLVERTON (SCIENCE AND ART INSTITUTE).

Butler, John Owen, 25, clerk—Shorthand (3d)
Evans, John Ernest, 17, clerk—Type-writing (3d)
Line, Walter James, 19, printer—Shorthand (3d)
Whitmee, James Thomas, 20, cabinet maker—Shorthand (3d)

YORK INSTITUTE.

Evans, Alfred, 20, clerk—Book-keeping (3d)
Porteous, Joseph John Williamson, 22, clerk—Book-keeping (1st)

YORK (RAILWAY INSTITUTE).

Towler, George, 17, clerk—Shorthand (3d)
Walker, John Henry, 17, clerk—Shorthand (3d)
Worthington, Thomas, 17, clerk—Shorthand (3d)

TABLE I.

Results of the Examinations of 1892 at Each Centre.

CENTRE OF EXAMINATION.	No. of Candidates examined.	No. of Candidates who passed.	No. of Unsuccessful Candidates.	No. of Papers worked.	No. of 1st Class Certificates.	No. of 2nd Class Certificates.	No. of 3rd Class Certificates.	No. of Papers to which no Certificate was awarded.	No. of Prizes.
Aberdeen, Civil Service and Business College	10	9	1	12	...	6	5	1	...
„ Music School	28	25	3	28	...	5	20	3	...
„ Robert Gordon's College...	76	61	15	78	11	21	31	15	2
Abertillery, Science and Art Classes	9	8	1	9	...	1	7	1	...
Belfast, School of Commerce ...	7	6	1	10	...	2	4	4	...
Birmingham and Midland Institute	62	51	11	63	7	16	28	12	...
Bolton, Church Institute	24	19	5	28	2	5	16	5	...
Bootle, Technical School	26	24	2	26	3	14	7	2	...
Bradford, School of Shorthand	18	14	4	19	1	7	6	5	...
„ Technical College	32	19	13	33	1	2	17	13	...
Brecon	5	5	...	6	1	3	1	1	...
Burnley, Mechanics' Institution	28	25	3	32	2	13	13	4	1
Carlisle	5	1	4	5	...	1	...	4	...
Carron	6	4	2	6	...	...	4	2	...
Chorley	7	4	3	7	...	3	1	3	...
Consett	5	5	...	5	...	3	2	...	...
Dalton-in-Furness	5	3	2	5	...	...	3	2	...
Dundee	23	21	2	24	...	4	18	2	...
Earlestown	8	8	...	8	6	2	...	...	...
Farnham	10	8	2	11	...	3	6	2	...
Glasgow, Athenæum	127	92	35	136	26	26	46	38	5
„ United Young Men's Christian Assoc. (Southern Sec.)	9	9	...	9	1	6	2	...	...
„ and West of Scotland Technical College...	15	13	2	15	1	4	8	2	...
Harrow-on-the-Hill...	3	3	...	3	...	1	2	...	...
Hownam	3	3	...	3	...	1	2	...	...
Huddersfield, Technical Schools	8	6	2	10	...	2	6	2	...
„ Young Men's Christian Association ...	9	6	3	9	2	1	3	3	...
Hull, Church Institute...	3	3	...	3	3	...	...	...	...
„ Young People's Institute	30	24	6	31	5	9	11	6	...
Ipswich, Working Men's College	6	4	2	8	...	...	4	4	...
Leeds, Yorkshire College	1	1	...	3	2	1	...	...	3
„ Young Men's Christian Association	40	40	...	40	8	24	8	...	...
Leicester, Working Men's College	19	13	6	20	1	3	10	6	...
Lewisham, Elswick Institute ...	12	12	...	13	1	5	6	1	...
Liskeard	1	...	1	1	...	...	...	1	...
Liverpool, Balfour Institute	15	13	2	15	7	3	3	2	...
„ Institute...	94	92	2	94	21	60	11	2	...
„ Young Men's Christian Association	91	79	12	93	22	44	15	12	...
Llanelly	1	1	...	1	1	...	...	...	1
London, Aldenham Institute	28	21	7	38	1	9	16	12	...
„ Birkbeck Literary and Scientific Institution	100	84	16	104	10	35	41	18	4
„ City of London College	91	84	7	94	14	38	35	7	3
„ College for Working Women	9	6	3	9	...	6	...	3	...
„ Hillmartin College	16	15	1	23	1	12	8	2	...
„ Holloway College	27	15	12	43	...	2	18	23	...
„ Metropolitan School of Shorthand	201	179	22	210	30	65	93	22	5
„ Mildmay-park	12	12	...	12	...	5	7	...	...
„ People's Palace, Mile-end	81	78	3	81	13	34	31	3	...
„ Poplar School of Music	3	2	1	3	...	2	...	1	...
„ St. John's Youths' Institute, Upper Holloway	6	..	6	6	...	...	...	6	...
„ School Board	137	105	32	140	7	49	51	33	...
„ United Westminster Schools	23	11	12	24	...	1	10	13	...
„ Westbourne-park Institute	3	2	1	3	...	...	2	1	...
„ Westminster, Technical Institute	19	10	9	23	...	6	5	12	...
„ Young Men's Christian Association, Exeter-hall	18	15	3	18	...	6	9	3	...
„ „ „ „ Institute, Polytechnic	119	90	29	140	13	31	55	41	...
Luton	5	4	1	5	...	3	1	1	...
Manchester, Lower Mosley-street Schools	99	87	12	101	9	20	60	12	...
„ School Board	276	260	16	310	66	111	111	22	6
„ Technical School	96	77	19	100	27	23	30	20	3
Market Harborough...	7	7	...	7	...	4	3	...	...
Middlesbrough, Grammar School	15	12	3	15	1	2	9	3	...
„ High School	13	...	13	13	...	...	...	13	...
Newcastle-on-Tyne, Science and Art School	30	15	15	32	1	8	8	15	...
New-cross, Goldsmiths' Company's Institute	63	58	5	65	8	20	31	6	...
Newton-heath	10	10	...	10	...	6	4	...	...
Norwich	2	2	...	3	...	2	1	...	...
Nottingham, University College	14	12	2	18	2	10	4	2	...
Oldbury	4	...	4	4	...	...	...	4	...
Oldham, Industrial Co-operative Society	17	17	...	17	5	9	3	...	...
Penzance, Mining and Science School and School of Art	12	8	4	16	1	2	5	8	...
Plymouth, Public School	48	29	19	63	2	8	24	29	...
„ School of Shorthand	22	15	7	25	1	2	15	7	...
Preston, Harris Institute	115	80	35	129	5	35	48	41	1
Reading	5	3	2	5	...	...	3	2	...
Rochdale, Engineering School	8	8	...	8	2	6	...	...	...
Salford, School Board	14	14	...	14	...	9	5	...	...
Sheffield, Young Men's Christian Association	9	8	1	11	...	1	8	2	...
Sherborne	3	...	3	3	...	...	...	3	...
Southampton, Alexandra College, Shirley	24	24	...	24	5	13	6	...	1
„ Hartley Institution	15	13	2	15	2	4	7	2	...
Carried forward	2,700	2,226	474	2,906	361	900	1,093	552	35

CENTRE OF EXAMINATION.	No. of Candidates examined.	No. of Candidates who passed.	No. of Unsuccessful Candidates.	No. of Papers worked.	No. of 1st Class Certificates.	No. of 2nd Class Certificates.	No. of 3rd Class Certificates.	No. of Papers to which no Certificate was awarded.	No. of Prizes.
Brought forward	2,700	2,226	474	2,906	361	900	1,093	552	35
Spennymoor	3	3	...	3	2	1	...	...	...
Stalybridge, Mechanics' Institution	25	25	...	28	4	13	11	...	...
Stevenage, Grammar School	11	7	4	11	...	1	6	4	...
Stockport, Technical School	18	4	14	18	...	...	4	14	...
Stockton-on-Tees, Young Men's Christian Association ...	6	1	5	6	...	1	...	5	...
Sunderland, Young Men's Christian Association	9	8	1	9	3	2	3	1	...
Swindon	15	12	3	18	1	4	10	3	...
Walsall, Science and Art Institute	43	32	11	44	2	9	22	11	...
Warrington Technical School...	4	3	1	4	1	1	1	1	...
Watford, Public Library	10	5	5	10	3	2	...	5	...
Wimbledon Institute	4	2	2	4	...	...	2	2	...
Wolverhampton, Free Library	46	24	22	48	1	5	20	22	1
Wolverton, Science and Art Institute	9	4	5	9	...	...	4	5	...
York, Institute	19	2	17	19	1	...	1	17	...
,, Railway Institute	6	3	3	6	...	...	3	3	...
Totals	2,928	2,361	567	3,143	379	939	1,180	645	36

No. of Centres, 96.

TABLE II.

Showing the Number of Papers Worked in each Subject, with the Results.

Subjects.	Number of Papers worked.	1st Class Certificates awarded.	2nd Class Certificates awarded.	3rd Class Certificates awarded.	Not passed.
1. Arithmetic	123	7	8	33	75
2. English	156	11	42	41	62
3. Book-keeping	1,375	211	574	456	134
4. Commercial Geography	32	5	7	13	7
5. Shorthand	616	32	92	295	197
6. Type-writing	98	9	17	35	37
7. French	155	19	33	49	54
8. German	122	42	20	40	20
9. Italian	9	5	3	1	—
10. Spanish	90	11	31	37	11
11. Portuguese	5	2	3	—	—
12. Russian*	—	—	—	—	—
13. Danish*	—	—	—	—	—
14. Chinese*	—	—	—	—	—
15. Japanese*	—	—	—	—	—
16. Domestic Economy	123	13	57	37	16
17. Theory of Music	239	12	52	143	32
Totals	3,143	379	939	1,180	645

* No examination was held in these subjects.

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